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ECONOMIC GEOGRAPHY

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MODERN FARMING IN THE VALE OF EVESHAM
Keith Buchanan

PINEAPPLE INDUSTRY OF HAWAII
James N. Wilson

THE BROKEN COTTON BELT
Franklin C. Erickson

HISTORIC FOREST FIRES IN MAINE
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EUROPE'S CRITICAL FOOD SITUATION
Ralph E. Birchard

LOCATIONAL FACTORS AFFECTING INDUSTRIAL PLANTS
Francis E. Elliott

LAND FORMS AND LAND USE EAST OF MONTEREY BAY
Charles Noble Beard

"HIGH FARMING" IN THE NORTH OF ENGLAND, 1840–1880
G. E. Fussell

CLARK UNIVERSITY, WORCESTER, MASSACHUSETTS, U.S.A.

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BROKEN COTTON BELT

THE widespread empire of old King Cotton in the United States has been broken, probably for all time to come. The American Cotton Belt, for many decades, was one of the world's most important and distinctive economic regions. The textile industry of the whole world, the summer garb of its millions of peoples, the network of interoceanic transportation routes, depended in large part upon the bundles of fiber so abundantly produced in the great American Cotton Belt.

The cotton belt originally comprised an area of physical and economic advantages for production, and yield of incomparable yields of cotton. Growing season, temperatures and rainfall; relief and drainage of terrain; texture, tilth, and composition of soils; abundance of labor, gracious countryside and copious water supply, and a rigid social system; all these attributes and many others laid the foundation for the profitable and long-enduring form of land use that distinguished the Cotton Belt.

Now conditions have changed. The continuous belt of cotton production, the territory over which King Cotton ruled the land, is shattered. New farms and systems of land use, new crops and farming practices, new industries and enterprises have invaded his realm and broken his sovereignty. Many causes contributed to that transformation in one of the world's great productive areas, some local, some international; some physical, some economic. The Cotton Belt is broken!

ECONOMIC GEOGRAPHY

VOL. 24 OCTOBER, 1948 No. 4

MODERN FARMING IN THE VALE OF EVESHAM

Keith Buchanan

THE market-gardening and fruit-growing district of the Vale of Evesham, occupying the Worcestershire section of the Avon Valley, is unique among agricultural regions of Great Britain. It is a major fruit-growing area of Britain; its orchards at blossom-time draw sightseers from all over the Midlands. It is the leading asparagus growing area in the country, the second sprout-growing area and important producer of crops ranging from radishes to gilliflowers, from leeks to loganberries. In terms of aggregate human and mechanical power applied per unit area it is probably one of the most intensively cultivated spots on the earth's surface. Most important of all it is home of one of the most vigorous and flourishing small holding communities in the British Isles. It is the aim of this study to outline the physical and social environments and the crop geography of the Vale.

PHYSICAL ENVIRONMENT

The Avon Valley region of South-eastern Worcestershire occupies an area of some 90 square miles. It consists for the most part of an undulating plain, rarely exceeding 200 feet in elevation and sloping west and southwest to less than 40 feet O.D. near Bredon. The general monotony of the area is relieved by the rounded mass of Bredon Hill, an outlier of the Cotswolds, which rises to 961 feet in the southwest; by the 350 foot plateau of the Lenches which hangs above the Avon, northwest of Evesham; and by occasional long low hills, such as Haselor Hill or Cleeve Hill, all of which afford islands of relative frost immunity above the generally frost liable lowlands. To the southeast the region is bounded by the thousand foot high scarp of the Cotswolds. Drainage is by the Avon which swings in lazy meanders across the region from northeast to southwest.

Geology.—Geologically, the region is comparatively simple. The greater part of the lowland is floored by the Lower Lias, consisting of blue calcareous clays with bands of limestone and shale. In the Bredon Hill and Cotswold areas the Lower Lias is overlain by younger rocks —Middle and Upper Lias and the limestones of the Inferior Oolite. Older rocks, represented by the red marls of the Keuper, are exposed by erosion along the north-south upfolds of Haselor Hill and Cleeve Hill (Figure 1-c). Over an extensive area, however, these "solid" formations have been mantled by drift deposits and they constitute an important factor in the agricultural geography of the area. They fall broadly into two groups—river terrace de-

posits and taele gravels. The terrace deposits consist of sands and gravels, of predominantly Bunter origin, of which the level surface and light easy-working soils make them ideal for intensive cultivation. Locally, as can be seen from Figure 1-c, width of the terrace belt attains two miles.

The taele gravels appear to have been accumulated under frozen ground condition from the adjoining limestone uplands and are well developed between the Avon and the Cotswolds and to the south of Bredon Hill. They are interstratified with quartzose sand and are locally mantled by a brown loam or brick earth which appears to have been derived from the gravels by a process of decalcification. Main spreads of drift deposits are indicated in Figure 1-c; their importance is evident from a comparison of the geological and land classification maps. It is, however, important to bear in mind that over much of the area mapped as "solid" Lias clay the surface soils contain an admixture of coarse quartz sand which suggests the presence in earlier times of a more extensive drift cover and which may have an appreciable effect on their cultural properties.

Soils.—A comprehensive soil survey of the region has been carried out by Long Ashton Research Station. (As

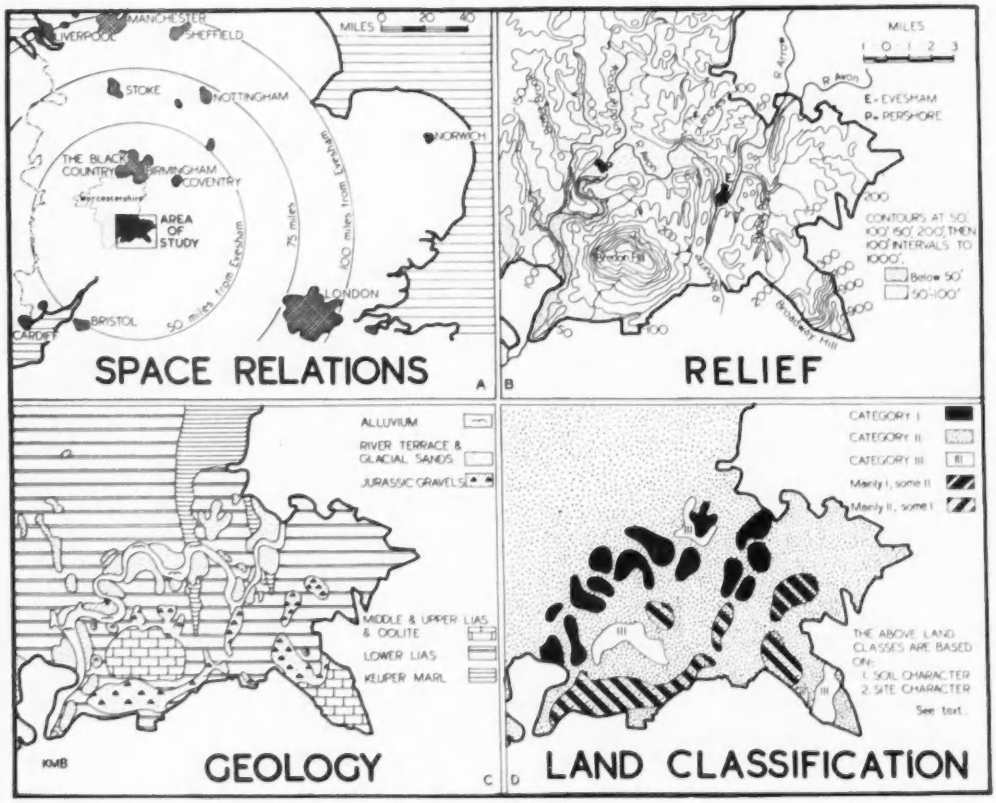

FIGURE 1.—Physical attributes of the Vale of Evesham are graphically presented in the illustrations—(a) relations between Evesham and principal conurbations of industrial England; (b) relief showing principal elevations and depressions; (c) geology, the underlying rock of several formations that enters into the relief and the soil; and (d) classification of the land and its potential uses on basis of site and soil character.

yet unpublished. The writer gratefully acknowledges the kindness of Prof. T. Wallace and Dr. D. A. Osmond in permitting access to their unpublished work.) The survey distinguished no less than 16 soil series in the eastern sector of the valley alone; many of them, however, are of only limited importance and for purposes of this study it will suffice to describe briefly the three most important series, Evesham, Badsey, and Pershore. The Evesham Series is by far the most important soil series in Southeastern Worcestershire. It is developed on Lower Lias clay, under conditions of lowlying, level or gently sloping topography and consists of some 4 to 10 inches of moderately calcareous grey or grey-brown clay or heavy loam overlying highly calcareous blue-grey clay. Drainage is slow and imperfect. Though heavy, soils of the Evesham Series possess remarkable cultural properties. Under influence of frost or alternate wetting and drying the surface soil breaks up into crumbs and attains remarkable tilth. The Badsey Series is associated with Jurassic gravels. A typical profile shows variable thickness of brown light loam to clay with cream coloured fragments of oolitic limestone and sharp transition to oolitic and Liassic gravel below. Drainage is imperfect for the gravels are frequently water-bearing. The Pershore Series is the characteristic soil developed on river terrace deposits overlying Lias clay. Texturally, it varies from light sand to heavy loam. In spite of some impedance in the lower layers by underlying Lias clay, drainage is moderately free in the upper layers and the soil is slightly podsolised with acid reaction at all horizons.

Any attempt to classify land of the Avon valley according to its inherent productivity is rendered extremely difficult by the very considerable modification of the original soils of the area by intensive cultivation. During the war years a land classification team of the West Midland Group on Postwar Planning made a reconnaissance survey of the whole West Midland Region, classifying the agricultural land into three categories on basis of physical factors of soil and site. (Land categories were based on (a) the soil character, i.e. depth, texture and water relations; (b) the site character, i.e. elevation, relief, aspect and climate.) Figure 1-d is based upon the work of this team, of which the present writer was a member, with slight modifications. (The major modification from the original map [see "Land Classification in the W. Midland Region," Faber & Faber, London, 1947] has been the reclassification of much of the area occupied by soils of the Badsey Series as I + II or II + I, thus recognising the presence in these areas, where depth and water conditions are favourable, of patches of first quality land, comparable with the better soils of the terrace belt.) It is seen that the greater part of the area, floored by soils derived from the Lias clay, is classified as Category II. or medium quality land. The major areas of Category I., or good quality land, coincide with major areas of river terrace deposits (Pershore Series). Soils derived from the Jurassic gravels (Badsey Series) vary somewhat in texture, depth and water relations and have been classed as I., II. or II.–I. according to the relative proportions of each category. Category III., or poor quality land, is confined to the steep slopes of Bredon Hill and the Lench plateau. The dominating feature which emerges from study of the map is the comparatively limited area of first quality land in the Valley and the fact that intensive fruit and vegetable production is carried on far beyond boundaries of Category I. land.

This point will be referred to later in this study.

Climate.—Climatically, the Vale is comparatively dry, with average rainfall of less than 25 inches. Winters are mild, with January mean maximum day temperature of 43 to 44 degrees though the area is swept periodically by devastating frosts. Summers are moderately warm. Perhaps the best index to the comparatively favourable microclimate of the Vale is its earliness as shown by response of vegetation; to quote Savory, a local writer, "Descending from Broadway or Chipping Campden, that is, from an altitude of about 1,000 feet to one of 150 or less, on a mid-April day, one exchanges within a few miles the grip of winter . . . for the hopeful greenery of opening leaves and thickening hedges and the withered grass of the hill pastures for the luxuriance of the Vale meadows." In a normal year the Vale is at least a week earlier than the Malvern district some miles westward, and a fortnight earlier than the northern part of the county. Against commercial advantages derived from such earliness must be set liability of much of the Vale, owing to its basin-like character, to destructive late spring frosts. Such frosts, and the years 1935, 1938 and 1944 were typical, may wipe out hundreds of acres of fruit blossom and early vegetables on the valley floor. Because of lateness of vegetation at higher elevations and because of inversion of temperature associated with such frosts, the damage on surrounding hills is generally slight. Relative immunity from frost, which the more elevated areas of the Vale enjoy, is encouraging, as will be seen later, a gradual redistribution of fruit growing in the district. (Thus during the 1944 frost, "the main damage to fruit and market garden crops in the Vale varies according to site altitude. Whereas the uplands almost wholly have escaped, the lowlying places suffered the full force of the blow." *Fruitgrower*, May 18, 1944, p. 372.)

THE SOCIAL ENVIRONMENT

The most striking features of the human geography of the Avon Valley region of Worcestershire are extremely small size of the average agricultural unit and intensity of cultivation. Over much of the valley, and especially east of the central town of Evesham, the land is almost entirely parcelled out into small holdings of four to ten acres, in many places consisting of numerous scattered strips worked largely by hand. Lack of space prevents detailed discussion of the evolution of the small holding system in the Vale. Suffice it to say that though some large farms were split up in the early nineteenth century, main development of small holdings has taken place during the last sixty years and is still continuing. In this development the County Council, acting under powers conferred by the 1908 Small Holdings and Allotments Act, has played a notable part; in 1939 total acreage of small holdings let out by the Worcestershire County Council was approximately 5,600 acres, 70 per cent of the total lying in the Vale of Evesham. (For development of small holdings see the writer's volume on "Worcestershire" in the series "Land of Britain," pp. 483–5, 649–51.) As can be seen from Figure 2-a the main stronghold of the smallholder lies in the east of the Valley; here over 90 per cent of the holdings are of less than 50 acres. (Figures for labour and holdings are based on the 1937 Agricultural Returns.) The parishes of Offenham and Bretforton, both close to Evesham, are typical: in Offenham 96 per cent of the holdings are under 20 acres and 66 per cent under five acres; in Bretforton the corresponding figures

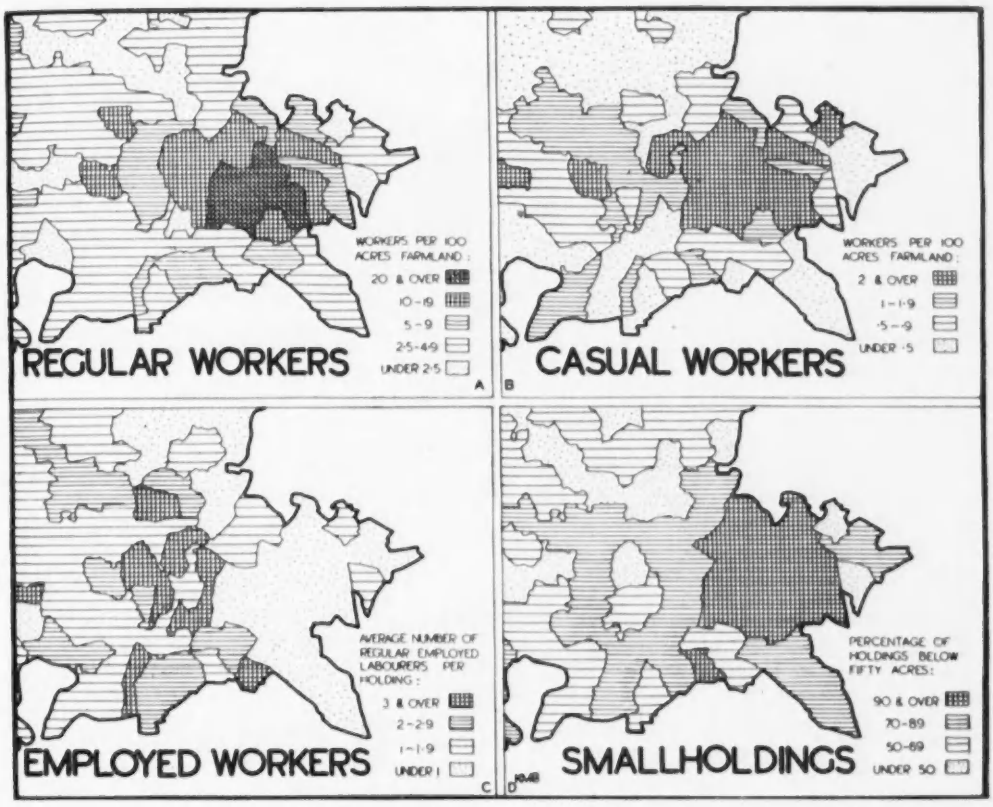

FIGURE 2.—Number and distribution of workers and their relation to small holdings is clearly revealed in this series of four maps—(a) workers per 100 acres farm land regularly engaged; (b) workers per 100 acres farm land casually employed; (c) average number of laborers per holding, regularly employed; and (d) the distribution of various sizes of holdings, both above and under fifty acres.

are 96 and 61. Passing westward from Evesham, importance of the smallholder decreases and of the larger grower increases until in some western parishes percentage of small holdings drops below the county average. Contrasts between east and west sectors of the Avon Valley are summarised in Table 1.

TABLE 1

Size of Holding	*Eastern Sector*		*Western Sector*	
Below 5 acres	61·8	96·8	28·5	80·2
5–20 acres	30·0		34·2	
20–50 acres	5·0		17·5	
Above 50 acres	3·2		19·8	

Contrast between the smallholder and the large grower is clearcut. The former cultivates a holding of five to ten acres with help of family labour and in recent years small rotary hoes and row croppers. The large grower operates on a holding which may run to several hundred acres with piecework labour and a high degree of mechanisation. There are significant contrasts in production between the two groups. The large grower tends to concentrate upon a restricted range of crops such as cabbages, sprouts and beans; the smallholder spreads his risks by growing a wide variety of crops, cabbages, sprouts, broccoli, peas, beans, leeks, onions, marrows, asparagus, flowers and perhaps tree and bush fruits.

Parcellation.—A further distinct fea-

ture of the Avon Valley area is the wide extent of parcellation. A single holding of, say, five acres, may consist of half a dozen widely separated plots. Figure 3, showing distribution of land belonging to eleven growers in a parish east of Evesham, is illustrative. The parcellation results from splitting up large farms for horticultural purposes. The typical smallholder began by cultivating a plot of land during his spare time; gradually he added to the spare time plot until he had obtained enough land to work full time on his own account. During the process of expansion he had to take whatever plots were available; frequently they were widely scattered. Today many gardeners live in Evesham while their holdings are scattered through adjoining parishes. Disadvantages of such a system are obvious and are recognised by Valley growers; it is, however, claimed, with some justification, that they are more than compensated for by the opportunity for "spreading" the risk of frost damage and by the variety of soils which it becomes possible to include in a holding. In view of the wide variety of crops which the average small grower cultivates, it becomes a factor of some importance. Individual strips or "lands" are marked off from the neighbouring grower's strip by only a furrow or path; consequently in the heart of the Valley the trim and regular pattern of small arable strips under wide variety of crops gives the landscape a distinctive, almost medieval open field, character.

Labour.—The visitor to the Avon Valley is further impressed by the intense application of human labour to

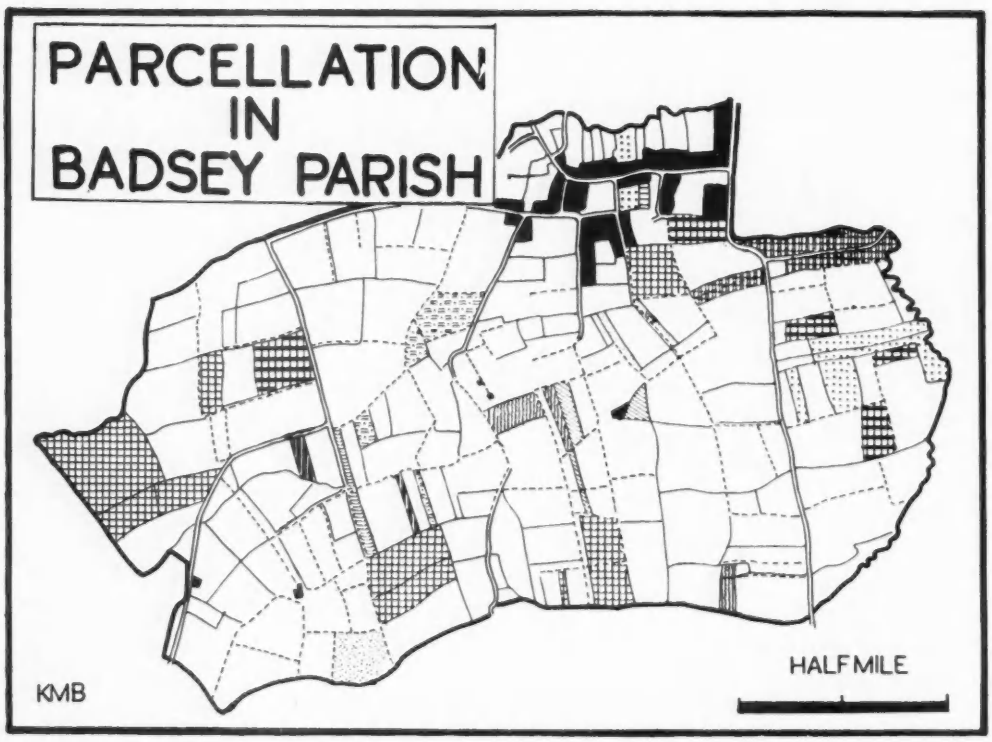

FIGURE 3.—In Badsey Parish distribution of land belonging to eleven growers illustrates the wide extent of parcellation. Each grower's tract is represented by a distinct symbol. A single holding, say of five acres, may consist of half a dozen widely separated plots.

the land. Much cultivation is by hand; the two-tined fork is widely used and many growers still dig their entire holding—possibly two to three acres of tenacious blue clay—over the slack winter period. The number of regular workers employed per unit-area is very high indeed, reaching 25 workers per 100 acres in some of the parishes east of Evesham (Figure 2-a). In the main small holding region little regular outside labour is employed; in the west of the valley, in contrast, average number of employed workers per holding is over three (Figure 2-c), though the figure conceals wide contrasts and individual holdings show totals of 20 to 30 workers. The small grower depends to a large degree on family labour at peak periods but occasional casual labour is required, density per unit area being highest in the eastern sector of the valley.

Evesham Custom.—It is impossible to deal adequately with evolution of land use in the Avon Valley without reference to the unique system of land tenure known locally as the "Evesham Custom." It is, as we shall see later, no exaggeration to describe the "Evesham Custom" as the most important single factor in the horticultural development of Southeastern Worcestershire. In the opinion of C. H. Gardiner the custom has gradually evolved after centuries of local usage. For long widely practised in the vicinity of Evesham, it did not receive any statutory recognition until the Agricultural Holdings Act of 1923. The Evesham Custom has two main features: (1) "It provides in the case of a good outgoing tenant a more generous valuation of tenant right than is customary on farmland, taking into account latent value of intensive cultivation, unexpired manures and tenant's improvements. Fruit trees, asparagus and the like are property of the tenant and unless the tenancy agreement contains an explicit covenant to the contrary, the tenant need not obtain permission of the landlord before planting trees or asparagus and carrying out reasonable improvements." (2) Right of an outgoing tenant to introduce a new tenant to his landlord at any time. "The landlord must accept the man put forward if he has good credentials as regards cultivation and husbandry and payment of rent. The cash value of the tenant-right is paid direct to the outgoing tenant. . . . If the landlord wishes to choose his own tenant in preference to one introduced by the old one he must pay out the latter at valuation, and it may prove to be a very heavy one, for value of the tenant-right on good market garden land is frequently higher than freehold value."

Advantages of the custom are obvious. The tenant has every incentive to raise his holding to a high level of fertility and to undertake planting permanent or semi-permanent crops such as tree-fruit, bush-fruit or asparagus. He enjoys a high degree of security since his landlord cannot turn him out without paying heavy compensation; as a result only a small proportion of market gardeners seek to own their land because such locking up of capital is unnecessary. The high payment for "ingoing" which is assured to a good outgoing gardener encourages a high standard of cultivation. The landlord benefits because the rent, as a result of the high value of the tenant right, is invariably secure and because risk of bad cultivation is negligible.

County Council.—The important part played by the County Council in the evolution of the smallholding system of the Vale has been referred to above. No less important has been the part played by the local Rural District Council in providing housing and services essential for a flourishing rural com-

munity. Up to the outbreak of war in 1939 the R.D.C. had provided 936 houses, of which one-half were let to market gardeners or agricultural workers; (taking the R.D.C. as a whole, over a quarter of the total population lives in Council Houses. Vol. "Future of Evesham" by C. H. Gardiner, p. 5) furthermore it has made generous loans to enable persons to build houses for their own occupance. With regard to provision of services the Vale is one of the most favoured areas of the Midlands; most of the villages have electricity or gas (or both), bus services are good, and in the east of the Vale all the parishes (with exception of the Lenches) have a piped water supply. Largely as result of efforts of the local authorities, the differential in living conditions between town and country has been reduced to a minimum and drift of land workers to

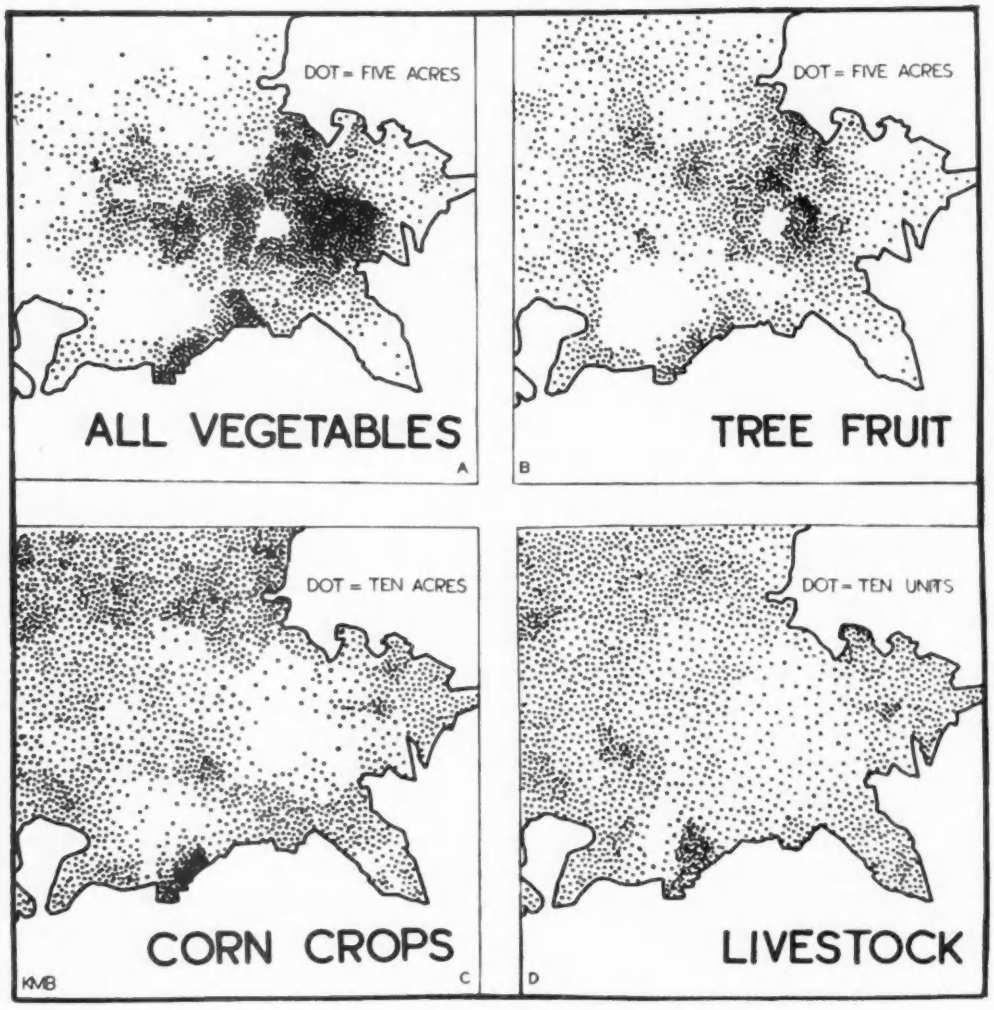

FIGURE 4.—Diversification of crops and types of farming in the Evesham area is apparent in this illustration—(a) distribution of all vegetables over the area, densely in part of the area, lacking in other parts; (b) tree fruits are closely correlated with vegetable growing; (c) the corn, or cereal crops are most densely grown where vegetables and tree fruits are little grown; and (d) livestock and the grain show a close correlation in distribution, the areas of density being almost coincident.

the towns, which was assuming such alarming proportions elsewhere in the Midlands, has in large measure been avoided.

CROPS AND CROPPING IN THE VALE OF EVESHAM

The area conventionally known as the Vale of Evesham coincides broadly with the drainage region of the Lower Avon Basin. More precisely, it may be defined as the area of Southeastern Worcestershire where horticultural crops occupy over one-tenth of the total agricultural area and which is characterised by certain cultivation and land-holding practices (e.g. intercropping, parcellation of holdings) which are unimportant elsewhere in the Midlands. As study of the various distribution maps presented with the paper will suggest, the Vale can be subdivided into two fairly clear-cut regions—an intensive and highly specialised eastern region centering on Evesham, and a less intensive western region centering on Pershore.

The most intensive and specialised area is contained within a circle some three miles in radius drawn from a point east of Evesham. Within the circle is found greatest concentration of vegetable production and lowest density of corn crops; it contains major blocks of orchard land and shows very low density of livestock. It contains also the major centre of small holdings and the area with the highest density of labour per unit area. Eastward, the transition to normal farming, chiefly grass farming, is comparatively abrupt; westward, the market garden area extends, with a somewhat lower degree of intensity of land use, along the Avon Valley to Pershore and south of Bredon Hill towards Tewkesbury.

Within the Vale as a whole the percentage utilisation of the agricultural land surface in 1943 was as follows:

Horticultural crops	30.5	
Orchards and small fruit		13.2
Vegetables		17.3
Other crops	39.9	
Grass	31.6	

The Valley as a whole, and especially the eastern sector, is conspicuous for its scanty livestock population. (Livestock units used in preparation of Figure 13 are: cattle—1, pigs—0.2, sheep—0.1.) The flood plain of the Avon contains some of the best pastures in the Midlands but they are limited in area and much of the grassland is of poor quality, occupying marginal areas unsuitable for horticulture. Sheep are almost completely lacking in some parishes and the dairy cow is the most important beast. Swine are most numerous but tend to be confined to larger holdings.

Southeastern Worcestershire was in the past a celebrated wheat growing area but within the last half century expansion of fruit and vegetables has led to rapid reduction in cereal acreage. As Figure 4-c suggests, corn crops occupy insignificant place in the economy of the main small holding area: here cereal acreage declined from 4,500 acres in 1880 to slightly over 200 acres in 1937. In the western part of the valley cereals are somewhat more important, occupying some 6 per cent of the agricultural area. Fodder crops (roots and clover) show somewhat similar distribution, occupying only 2 per cent of the agricultural area in the east and 4.8 per cent in the west.

In the mind of the typical Midlander "Evesham" and "orchards" are inseparable. Acreage under fruit in the Vale is some 8,000 acres or approximately one-ninth the agricultural area. As Figure 4-b shows, greatest concentration of fruit is in vicinity of Evesham, where

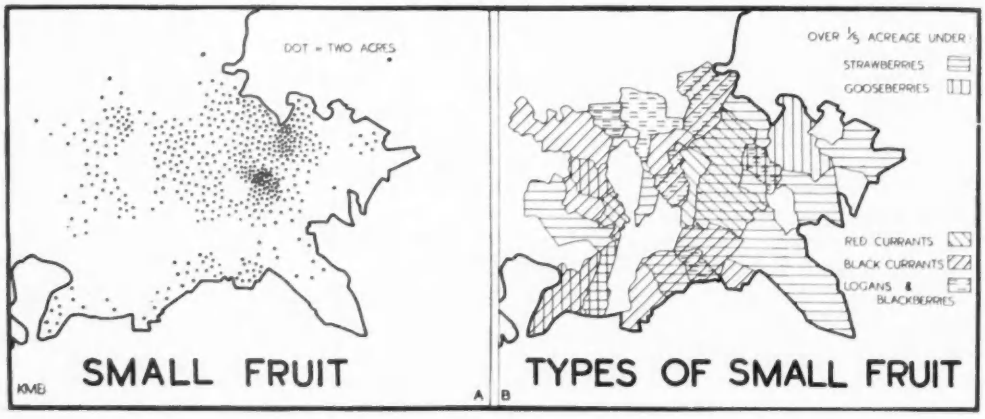

FIGURE 5.—Distribution of small fruit and distribution of several types of small fruits are presented in maps (a) and (b) respectively of this illustration. Strawberries are grown over most of the territory, red currants and black currants and gooseberries follow next in importance, and loganberries and blackberries are most localized.

greater part of the fruit acreage is undercropped with bush fruit and vegetables. Of the total acreage, three-quarters consist of plums for, more than any other fruit tree, plums flourish on heavy soils of the Lower Lias while their manurial requirements (plentiful supplies of nitrogen) are similar to those of the vegetables with which the orchards are intercropped. Recent years have seen a marked change in character of cultivation. Increasing use of winter sprays, especially tar oil, has been difficult to reconcile with intensive intercropping with winter vegetables, and the small grower has tended to concentrate his energies increasingly upon vegetables and bush fruit, leaving tree fruit production to the larger growers. They have tended to develop on the higher frost free land around the Vale, and on such specialised holdings intercropping is not common.

Area under bush fruit in the Vale in prewar years was about 1,200 acres; it dropped during the war years to c. 1,000 acres. The total represents somewhat over one-third of the total for Worcestershire and about one-fiftieth of the entire national acreage. Distribution of small fruit in 1943 is shown in Figure 5-a; the major feature of distribution being concentration in the east of the Vale, especially in the Cleeve Hill area and immediately eastward of Evesham. Of the total acreage, one-half, lying mainly in these two areas, is grown under top fruit and a large proportion is intercropped with vegetables. Contrasts in distribution of various types of small fruit are shown in Figure 5-b. Strawberries and gooseberries are the dominant small fruit type in the main small holding area, gooseberries showing pronounced localisation in the Cleeve Hill area. Red and white currants are most important in the centre of the Vale, especially in vicinity of Evesham and Charlton; black currants, in contrast, are most important on fringes of the Vale and on bigger holdings. Loganberries and blackberries are of increasing importance, the main producing area lying on the light podsolic soils of the Cropthorne and Offenham area and on the northern fringe of the Vale between Pinvin and the Lenches. Percentage composition of the total small fruit acreage in the Vale is given in Table 2.

TABLE 2

PERCENTAGE COMPOSITION OF SMALL FRUIT ACREAGE IN THE VALE

Strawberries	20.1
Raspberries	6.4
Black Currants	19.2
Red and White Currants	13.8
Gooseberries	20.1
Loganberries and Blackberries	21.5

Distribution of vegetables is shown in Figure 9-b. As in case of fruit there is very marked concentration in parishes east of the town of Evesham. Here the area devoted to vegetable growing represents over one-third the total agricultural area (one-half in the case of parishes such as Badsey and Offenham) as compared with one-sixth in the western part of the Vale.

The typical Evesham rotation, yielding three crops in two years, is usually given as:

(i) Spring cabbage autumn planted, cleared by April,

(ii) sprouts transplanted in May, first picking in September, cleared by early spring,

(iii) peas or beans, spring planted, cleared by late summer.

Few smaller growers follow any clear-cut rotation, however, and in any case wide variety of soils precludes any uniformity of cultural practices. Total acreage and relative importance of various vegetable crops is summarised in Table 3.

TABLE 3

VEGETABLES IN THE VALE OF EVESHAM, 1943

Crop	*Acres*	*Per Cent Total Vegetable Acreage*
Sprouts	4,313	37.1
Peas	2,046	17.6
Runner beans	1,313	11.3
Onions	720	6.2
Asparagus	619	5.2
Cabbages	572	4.9
Cauliflowers and broccoli	496	4.2
Broad beans	456	4.0
Parsnips	281	2.4
Beetroot	194	1.7
Carrots	76	0.6
Lettuce	76	0.6
Turnips	42	0.3

Worcestershire is second producer of sprouts among the English counties and of the total county acreage four-fifths is concentrated in the Vale, occupying over one-third the total acreage under vegetables. The crop is grown all over the Vale, but is especially important on medium to heavy loam soils in the eastern sector and on the southern fringe. It is grown on both large and small holdings and to an increasing extent, on the fringe of the Vale, by general farmers, either as a cash crop or on contract to larger growers. The 1943 acreage—4,313—represents an increase of 800 acres on the prewar figure. Cabbages, in contrast are grown especially on light to medium loam soils of river terrace deposits. Since greater part of the crop is cut by May (i.e. before collection of the official June Agricultural Returns used in this study) Map 10-b and Table 2 give inadequate picture of the importance of the crop. Supplementary data collected in the war suggests that total cabbage acreage for the county is 350 to 400 per cent of the June acreage and this figure may be applied to the Vale acreage giving an estimated total of 2,000–2,250 acres under the crop. Beans and peas, too, show some contrasts in distribution. Beans are grown widely on the heavier soils of the Vale, the broad bean especially lending itself to intercropping with marrows, sprouts or other crops. Peas are less suited to intercropping and tend to be of importance chiefly on larger holdings and lighter soils of river terraces.

Other vegetables grown in the Vale include asparagus, parsnips and carrots, turnips and swedes, leeks, marrows, radishes, salad crops such as spring onions and lettuces, flowers and herbs and, especially during the war, outdoor tomatoes. Together, the crops occupy some 2,400 acres or approximately one-

fifth the total acreage under vegetables. Production is largely in the hands of the small grower and they are of particular importance in the east of the Vale. Here, as can be seen from Figure 9-b, they occupy between a quarter and a third of the land devoted to vegetables; in the parish of Badsey, one of the main centres of the small grower, they account for 42 per cent of the vegetable acreage. In the west of the Vale they are of much smaller importance, rarely occupying more than one-eighth of the vegetable acreage.

Among such more specialised crops, asparagus is of major importance. Worcestershire is the leading producer of this crop in Britain; of the total Worcestershire acreage (c. 1,200 acres prewar) 97 per cent comes from the Vale. Asparagus is largely absent from the west of the Vale; in the east by contrast it occupies over one-tenth of the arable area in the parishes of Bretforton, Badsey, Cleeve Prior, North and Middle Littleton, Wickhamford and Cow Honeybourne. The crop is essentially a smallholders' crop, attempts at large scale cultivation having proved unsatisfactory, and is semi-permanent, occupying the land for 10 to 15 years.

Rapid succession of crops is ensured by skillful intercropping; thus tree fruit may be under-planted with bush-fruit, with sprouts intercropped with marrows or beans between the rows. Manuring is very heavy, the most widely used fertilisers being hoof and horn, meat and bone, dried blood, bone meal, guano and artificial fertilisers; owing to the scanty livestock population foldyard manure is little used. A development of some importance in recent years is overhead irrigation, using water from the Avon, especially with green crops in planting and during dry spells.

Details of three typical horticultural holdings will help to fill in the above sketch of crops and cropping practices.

Holding I. This is a typical large market garden holding located in the west of the Vale:

Acreage 110, of which 45 fruit.

Arable cropping. Major crops are sprouts, runner beans, spring cabbages and peas, about 20 acres of each being grown in a normal year. Also parsnips, beets and carrots, lettuces, onions and radishes, the three latter crops being

FIGURE 6.—The Vale West of Evesham Town. Tree fruit, bush fruit and rhubarb; Haselor Hill in the distance with vegetables on lower slopes and fruit on less frost-liable upper slopes.

grown chiefly to keep workers during slack spring period.

Cultural details. Sprouts are followed by peas at end of February. In late June or July the peas are skimmed, ground is top-cleaned and cabbage drilled at 20 inches to stand. These are thinned in early autumn and marketed in February. Fertiliser expenditure very heavy, reaching £4,000 per annum at war-time prices. (£1,000–£2,000 prewar.)

Fruit. Entirely plums, especially dessert varieties with canning varieties to spread the picking. Younger plantations are intercropped with blackberries and black currants.

Labour (1942). Fifteen men, 13 local women and 18 Land Girls. Three tractors.

Markets for fruit. Fifty per cent to canners, most of remainder to private trade in North of England.

FIGURE 7.—Spring in the Vale. Young plum trees with raspberries in the tree rows. Ground between cleaned ready for summer vegetables. Note cloddy nature of soil. (Evesham Series.)

FIGURE 8.—Evesham-Style Cultivation. Plums, with bush fruit in and between the tree rows; ground between rows cleaned for sprouts.

Holding II. is in the parish of Badsey, east of Evesham.

Total acreage five, in three plots. Crops include asparagus one acre, sprouts one acre, currants one-half acre, onions, leeks, spinach one acre, sage and thyme one-half acre, one-half acre of marrows intercropped with beans, small areas of onions, tomatoes and parsnips.

Manures used include one ton of hoof and horn, one ton of meat and bone, four cwt. of potash salts followed by guano. Worked by occupant with occasional casual labour.

Holding III. consists of three and one-half acres in two plots, is worked by a gardener who also does occasional casual work on other holdings.

Crops include one-half acre of asparagus, one acre of sprouts, intercropped with dwarf beans, one-half acre of peas, one-fourth acre of dwarf runner beans, two chains of green onions. Remainder is under potatoes for home use.

DEVELOPMENT OF THE VALE OF EVESHAM

Reviewing factors which have contributed to development of the Valley, six would appear to be outstanding.

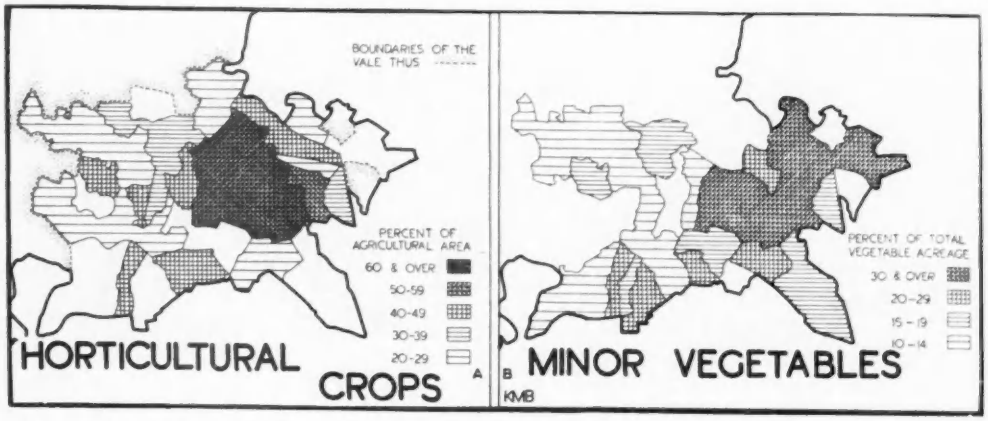

FIGURE 9.—Areas of relative densities and their distribution over the Vale, of (a) horticultural crops, and (b) minor vegetables indicate a rather close relationship in some of the area, but very little in other areas.

In descending order of importance they are:

1. The Evesham custom.
2. Progressive local authorities.
3. The character and skill of the Valley grower.
4. The highly developed marketing organisation.
5. The favourable position of the Valley in relation to the main consuming areas of the country.
6. Climate and soil factors.

Purely physical features rank low among the suggested factors though favourable situation in relation to four great consuming areas—London, the West Midland conurbation, the Northern towns and South Wales, "the salvation of Evesham," has been a factor of some importance. (See Figure 1-a.) Here reference may well be made to the highly efficient marketing organisation in the Valley which has enhanced the advantages of geographical position. There are 14 railway stations within five miles of Evesham, and as early as 1906 one of the leading local growers observed, "We have an almost perfect train service to every part of the kingdom"; since then the extension of road transport has strengthened the link between the Valley and consuming centres of the Midlands; and in the more purely economic sphere, development of coöperative ventures, such as the Littleton and Badsey Growers Association, has lessened dependence of the small grower on the big dealer-growers or the commission salesmen and has given him a greater control of his own economy.

Climatically, the advantages and disadvantages of the region have been indicated above; it is undoubtedly one of the earlier districts of interior England, but even in Worcestershire the Kempsey district would seem to be at least as early, perhaps earlier than, and compared with parts of Southern England the Valley is relatively late; frosts, too, have been shown to be an adverse factor of some importance. Soils are variable and the Valley district includes some of the best and some of the worst soils in the county. The drift-derived soils such as the Pershore Series and the Badsey Series are well suited to intensive cultivation and it can be shown that such lighter soils played important part in early development of the horticultural industry; with spread of market

gardening, however, heavier and lower grade soils were brought into cultivation and if some of them, such as the Evesham Clay are today highly productive it is well to recall that sixty years ago farmers faced economic ruin trying to produce on such land, and that even today some of the most miserable grassland farming in the counties of Worcestershire and Warwickshire is to be found on the heavy Lias soils. The conclusions of L. Jebb may well be quoted here. "Much of the soil in this district is of indifferent quality, and its value is due more to thorough cultivation and high manuring than to anything inherent in its nature. . . . We have several instances where many small men are earning good living and paying high rent on heavy land where earlier farmers had failed. While admitting, therefore, that in the first instance, rich soils of the

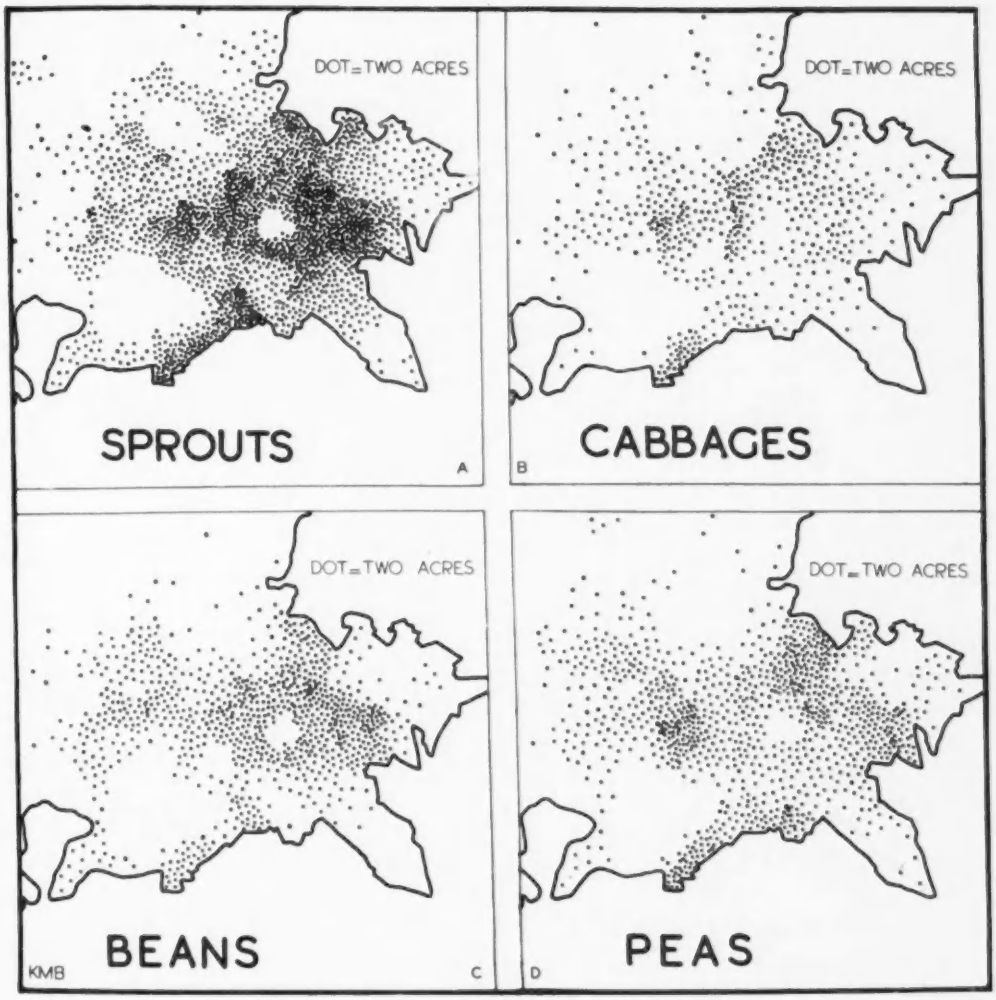

FIGURE 10.—The distribution and relative density of some of the major vegetables grown in the Vale of Evesham represent rather nice adjustments to the terrain and other features of the area, as well as to types of farming and other crops grown: (a) rather wide distribution and high acreage devoted to sprouts; (b) smaller acreage but equally wide distribution of cabbages; (c) lower density and more restricted distribution of beans; and (d) relatively close correlation between areas devoted to peas and beans.

Avon Valley, combined with the early climate, caused introduction of market gardening, spread of the industry farther afield has educated the local men up to the discovery of how to cultivate inferior soils to achieve the same results." And C. H. Gardiner goes to the root of the problem when he says, "The success of Evesham growers who have taken land far outside the Vale of Evesham goes to prove that the high tilth and productivity of the soils is due, not to the soil, but to the men who cultivate it."

The skill of the Evesham grower must be placed high among factors which have contributed to development of the Valley. With the hereditary skill there is linked intense pride in maintaining high standards of cultivation, a spirit of enterprise far above that of the average farmer and a rugged individualism which gives to the small grower immense staying power under adverse conditions. Nevertheless, without security of tenure and financial protection which the Evesham Custom affords to a grower with skill and initiative, few smallholders would have been able to participate in developments which followed collapse of the traditional farming of the Vale in the late nineteenth century, and without the wise and farsighted policy of the local authorities—the County Council in creating small holdings, the Rural District Council in providing houses and services essential for a healthy rural life—the small holding movement would have been in large measure stillborn.

PINEAPPLE INDUSTRY OF HAWAII

James N. Wilson

DURING the Second World War, shortages in a great many commodities developed. Pineapple products, however, were unique in being one of the very few commodities which practically disappeared from the civilian market—partly result of wartime shipping conditions. However in much larger part it was result of certain peculiarities in the organization, structure, and location of the pineapple industry itself.

Pineapples are grown over many parts of the Tropics—Hawaii, Cuba, Mexico, Brazil, Formosa, the Philippines, the East Indies, Australia, Malaya, Burma, India, the Bahamas, and the Azores being noteworthy producers. Over 80 per cent of all of this fruit which enters world trade, however, is grown in the Hawaiian Islands (see graph). With very few other commodities is there such sharp localization of commercial production. The fact alone is sufficient to make both Hawaii and the pineapple industry, as geographical phenomena, worthy of considerable study.

Environmental Factors

Latitude. Hawaii lies in practically the same latitude as Cuba. A map of the island group superimposed upon Cuba is shown in Figure 1. The northern tip of the "Big Island" of Hawaii touches the southeast corner of Cuba; the islands of Maui, Kahoolawi, Lanai, Molokai, and Kauai trend up the northeast coast of Cuba; and the small westernmost island of Niihau stands just east of the Trinidad Highlands of central Cuba.

Climate. The Hawaiian Islands lie athwart the Northeast Trades which cool them so effectively as to render them delightful and relatively invigorating. Sea-level temperatures in Hawaii usually average between 68 and 74 degrees F. It is a rare summer day in which temperatures rise to 85, and an equally rare winter night when they drop as low as 60 degrees.

Although Hawaii resembles Cuba in latitudinal position, their surface configuration is quite different. In contrast to the general lowland plain character of Cuba, the Hawaiian Islands are rugged tops of a volcanic mountain chain rising from a deep ocean floor. Mauna Kea, for instance, is several hundred feet higher than Mt. Everest if measured from its submarine base to its crater rim. The effect of the mountain-peak character of the Hawaiian Islands is to produce marked vertical zonation in temperature. All the islands possess well defined "Tierra Caliente" and a "Tierra Templada." A "Tierra Fria" occurs on the "Big Island" where Mauna Kea and Mauna Loa rise almost to 14,000 feet above sea level and carry snowfields for several months each year.

The mountainous nature of the Islands strikingly affects distribution of their rainfall. Total precipitation as high as 300 inches characterizes the windward side, whereas only 5 or 6 inches may fall on the leeward side. The island of Lanai is thus unfortunately located, because even its windward shore lies in the lee of Maui and hence falls within the rainshadow of the latter.

Most pineapple fields are not irri-

gated because the fruit requires no more water than does a crop of corn. Thus it tends to avoid both wetter areas and extremely dry localities. The arable lands of Lanai are almost entirely planted to pineapple, but owing to the rainshadow position of the island, droughts have been frequent. As result of the recent 1945–1947 drought, deep wells are being drilled to provide auxiliary water supply.

deficiency. After considerable research, pineapple companies discovered that an iron sulfate solution sprayed directly onto the plants was readily absorbed, thereby remedying the deficiency.

Location. Despite advantages of rich soils and climate better than that of most tropical lands, Hawaii suffers from poor geographic location. It is far removed from the world's greatest market, continental United States. Honolulu,

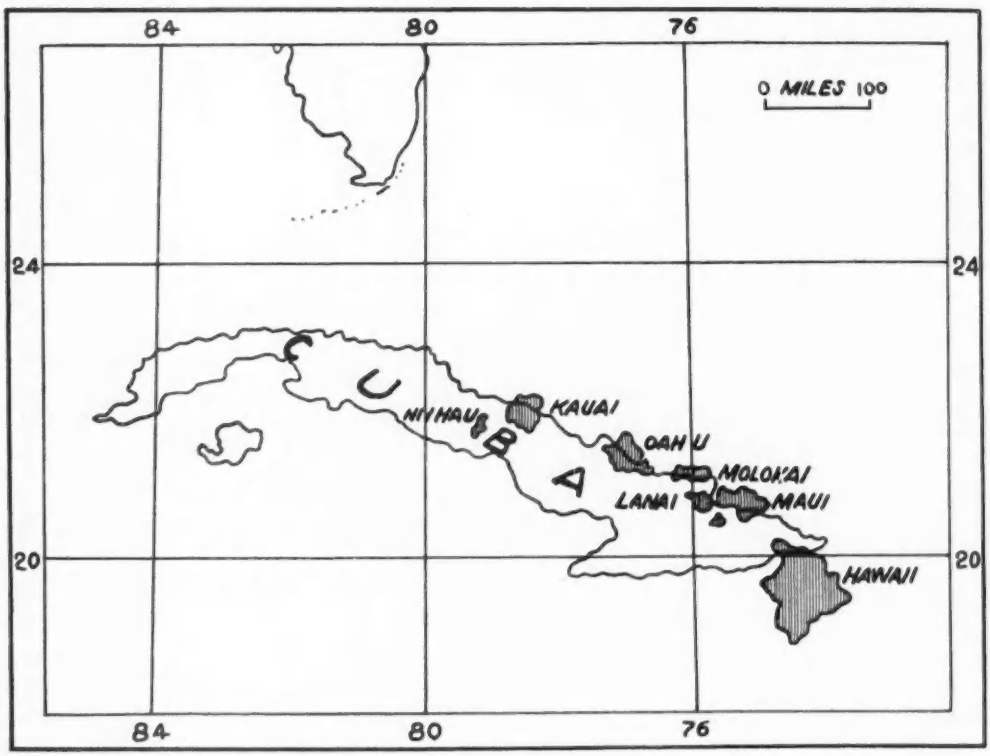

FIGURE 1.—The Hawaiian Islands superimposed on Cuba showing relative size. Although Hawaii occupies nearly the same latitudinal position as Cuba, its surface configuration is quite different. In contrast to the general lowland plain character of Cuba, the Hawaiian Islands are the rugged tops of a volcanic mountain chain rising from a deep ocean floor.

Soils. Soils of Hawaii are deep, rich clays from decomposed volcanic materials, rich in manganese, iron, and alkaline materials, and capable of sustained yields under cultivation. As manganese oxidizes, however, it unites with iron, and renders it unavailable to the pineapple plant with the result that the crop has long suffered iron

principal port of the island, lies 2,100 miles from San Francisco. By way of comparison, Habana is only 600 miles from a market in New Orleans. Honolulu is even farther from Asiatic and European markets than from North American outlets.

Limited Area. The Hawaiian Islands, all told, cover less than 6,500 square

miles, of which a large proportion is too rough, rocky, or steeply sloping to be of much agricultural value. About 60,000 acres, or less than 1½ per cent of the total area, is devoted to pineapple production, and practically all land suitable for the industry has already been taken up. The acreage is adequate for present needs and for expansion in the near future, but does not promise indefinite growth.

For the most part, Hawaiian pineapple fields are planted on interior upland areas, avoiding lowlands with their high water tables. The lowland areas are ideal for sugar cane; hence the two crops, instead of competing for land, tend to complement each other in land use.

ECONOMIC FACTORS

American Market. In 1900, as result of the desire of the Hawaiian people, the Islands were organized as a territory of the United States. Since that date, political stability, freedom of economic enterprise, and an American system of public education, have produced conditions in Hawaii nearly as favorable as in the mother country.

Lack of tariff barriers between Hawaii and the mainland give the Islands a commercial advantage difficult to overestimate. Certainly, free trade with the United States was the most important single factor encouraging growth of the pineapple industry during its early stages.

Absence of economic restrictions has resulted in very high per-capita trade between Hawaii and the mainland. The population of the former is approximately 450,000; and yet, total imports from the United States in 1940 amounted to more than $127,000,000. In that same year, exports to the United States exceeded $102,000,000. Total trade with the mainland thus amounted to about $230,000,000. In comparison, total trade with all other countries amounted to less than $10,000,000.

American Capital. Freedom from customs levies, trade restrictions, quotas and exchange controls, ordinarily met in foreign markets, has attracted large amounts of American capital to the Islands, particularly noteworthy in connection with the pineapple industry, where eight American companies are engaged in production. The first company that began pineapple canning, the Hawaiian Pineapple Company, Ltd. (HAPCO), is today the largest—producing and processing nearly 40 per cent of the total output. Ranking next are a subsidiary of Libby, McNeill, and Libby, and a subsidiary of the California Packing Corporation which, combined, account for about 45 per cent. The remaining five companies produce about 15 per cent of the total.

Large Scale Operations. One of the major advantages enjoyed by the pineapple industry in Hawaii is its large-scale organization, from which results many economic advantages over other producing regions. Holdings of HAPCO illustrate the vast scale of operations.

In 1922, HAPCO purchased the entire island of Lanai to expand acreage under pineapple cultivation. An airplane view of the island is a beautiful sight, for the symmetry and design of contour-planted rows spiraling around slopes of a knoll form an attractive pattern, intermixed as they are with the long, perfectly straight rows on more level land.

The cannery owned by the same concern on Oahu is the largest fruit cannery in the world. It is an interesting establishment to visit. The modern buildings, the cleanliness, and the courtesy found in it are refreshing, as is also the ice-cold pineapple juice which pours from a tap in the wall. Located here is a

water tower which is shaped and painted like a huge pineapple, to form a well-known landmark. The plant has capacity of four tons of fruit per minute, while the greatest single day's pack of canned pineapples was almost five million cans.

Scientific Research and Technological Advances. Immense resources and huge capital reserves of the Hawaiian corporations enable them to carry on an amazing program of research, which ramifies into ground water geology, soil science, botany, parasitology, bio-chemistry, and production engineering. Indeed, one of the most significant aspects of the Hawaiian pineapple industry is the degree to which science has been called upon to aid in growing and processing the fruit.

PINEAPPLE PRODUCTION

Although pineapples may be, and to a certain extent are, grown in many portions of the Tropical Zone as a local supply crop, commercial production is limited to about nine countries, as shown in the accompanying graph.

From a glance at the graph (Figure 2), it is evident that Hawaii dominates world trade in pineapples, a dominance which offers a key to the peculiar behavior of the pineapple market during the Second World War. Canned pineapple and pineapple juice offered a compact, readily available source of citric acid for the diet of the American Armed Forces. Accordingly, most of the Hawaiian supply was diverted at the point of origin into Army and Navy channels. Philippine, Formosan, Indonesian, and Malayan production declined markedly, but whatever remained was diverted into Japanese military channels. Cuban, Indian, and other supplies were largely unutilized because of need for shipping to haul other more essential commodities. As a consequence, the pineapple is even now just beginning to reappear in the American market in anything like normal quantity.

SOME HIGHLIGHTS ON HAWAIIAN PINEAPPLE INDUSTRY

The exact date at which the pineapple was introduced into the Islands is unknown. In 1813 it was recorded that they were being grown in the gardens of King Kamehameha, the native ruler of Hawaii. The first commercial cannery was started by Ackerman and Muller on the island of Hawaii in 1882, but the crop was so uncertain that constant supply of raw materials was im-

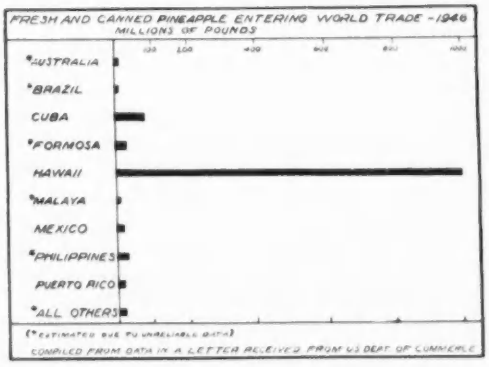

FIGURE 2.—Though pineapples are grown in many parts of the Tropics including Hawaii, Cuba, Mexico, Brazil, Australia, Malaya, Burma, India, the Bahamas and the Azores, over 80 per cent of all the fruit which enters the world trade is grown in the Hawaiian Islands. Very few commodities represent such sharp localization of commercial production. It is evident that Hawaii dominates world trade in pineapples.

possible, and the attempt at canning unsuccessful.

Weed Control. During the first few years of cultivation, weeds choked the young pineapple slips and presented hindrance to large-scale cultivation. Population of the Islands was and still is small in number. As the task of hand-cultivation involved long man-hours of work, extensive planting was impossible. Either number of workers available had to be greatly increased or weeds controlled in some other way.

The problem was largely overcome by use of bagasse, a name given to the waste fibers from the sugar factories, in making mulch paper. The paper is laid down in long strips across the plowed fields. Then two rows of holes are punched in the mulch paper so that the pineapple slips can be inserted into the soil. The use of the paper was found to provide several advantages. First was prevention of weed growth immediately around young plants. Second was retention of heat in the soil, and third was prevention of rapid evaporation of moisture into air from soil.

The machine that lays mulch paper has been improved to such an extent that today in one operation it fertilizes and fumigates the soil, lays the paper, and piles dirt along edges of the paper to hold it in place. Later another machine punches holes in the paper and inserts the pineapple slips or shoots through the holes and into the soil.

Worm Control. A few years after use of mulch paper was begun in the pineapple fields, there was perceptible drop in yield of the fruit per acre. Investigation revealed nothing wrong with the mulch paper that might cause such condition, so further analysis of all factors affecting pineapple growth was begun. The cause was found to be related to the *use* of mulch paper but not to the paper itself. Certain parasites, especially nematodes, which are microscopic eel-like worms, had multiplied rapidly under the paper, for it provided them a safe home. Nematodes caused the root system to become gnarled and stunted, which in turn impeded the plant from taking up sufficient food from the soil for proper development. After a few years the fields became so thoroughly infested with the parasites that plants would not mature.

One remedy, not too satisfactory, was found in rotating crops. When a field became badly infested, pineapple plants were plowed under and planted to pigeon peas or some other green manure crop. The practice eliminated protection afforded by the mulch paper for the parasites, and after two years of such planting, the percentage of parasites in the soils would drop enough so that the field could be replanted in pineapples. Rotation of crops also helped restore depleted elements to the soil.

Since such plan of rotation lowered total yield considerably, it was an expensive remedy and so was not accepted as the final solution. The Pineapple Research Institute continued to work on the problem. The organization, supported by the Hawaiian pineapple industry, decided the ultimate goal to

FIGURE 3.—The pineapple and products derived from it constitute one of the basic commodities in the economy of Hawaii. In World War II, this basic commodity practically disappeared from the civilian market, in part because of war-torn shipping conditions, but in much larger part because of distinctive factors in organization, structure and location of the pineapple industry itself. (Courtesy of the Hawaiian Pineapple Company.)

be achieved would be in the form of a cheap soil fumigant. Effective fumigants were available, but prohibitive in cost. By 1943 the Institute was satisfied that the goal had been reached. Almost equal quantities of dichloropropene and dichloropropane in liquid form made up the new fumigant. Referred to as D-D, not to be confused with D.D.T., the fumigant killed not only nematodes, but other harmful bacteria and insects, and even some harmful fungi. Since the present cost is 11½ cents a pound, and is expected to drop more as volume production gets under way, D-D is a cheap fumigant.

To date the use of D-D seems to hold great promise. Many fields have produced from 10 to 20 tons more pineapple per acre than had been raised before it was used; and it holds promise of greater yields for other crops too. The Department of Agriculture has conducted experiments with D-D and found it to be highly effective on hitherto unproductive farm lands in continental United States. Increases in returns of $500 per acre in vegetable planting have been realized for an expenditure of only $40 per acre. It is thought that many farms in southern United States also may return to productivity through its use.

Insect Control. A pest which attacked the superstructure of the plants was the mealy bug, the so-called milch cow of the ants. The mealy bug feeds on green leaves of plants. The leaves radiate outward, acting as funnels to carry rain

FIGURE 4.—Close adjustment of pineapple planting and cultivation to contour of terrain upon which the fruit is grown, characterizes the area of commercial production. The pattern of planting reflects direction and degree of slope. (Courtesy of Hawaiian Pineapple Company.)

and dew to the fruit. If badly damaged, the leaves fail to serve the fruit, and pineapple wilt, descriptive name for the blight, follows. By spraying plants with insecticide, the mealy bug was easily controlled. Today large-area spraying machines do the job.

Labor Saving in the Fields. The scarcity of workers for extensive pineapple cultivation is an ever-present problem. The elimination of as much tedious hand labor as possible is one of the aims of the research organizations and plantation engineers. For instance, hand fertilization of the pineapple plants took long hours and many men in the fields. To overcome the handicap, a high-speed machine has been devised that gently pushes aside the spear-like leaves and deposits food at the base of the plant.

Another machine for reducing man-hours on the plantations is the cultivator. It, and the use of weed spray, complete the task of weeding not accomplished by the mulch paper so that virtually all hand weeding has been eliminated.

Although pineapples take from 18 to 20 months to ripen after planting, the harvest period is confined to a limited peak season of three months during July, August and September, with consequent inconvenience in much additional hand labor, both in harvesting in the fields and in processing at the factories. One of the most recent inventions to make harvesting easier and quicker is the mechanical harvester, of such recent development that large-scale use has not yet been achieved.

Formerly pineapples were picked by hand and placed in a sling carried over the shoulders of the workers until the sling became full. The worker then took his sling, heavy with fruit, to the end of the row on which he was working. Here the fruit crowns were cut off and the fruit placed in lug boxes, to be picked up by truck. Loading of boxes in the fields and unloading at the factories demanded additional heavy manual labor.

The mechanical harvester has a long boom with an endless belt which swings out over the pineapple field. As workers pick the fruit, they immediately cut off the crown, then place the fruit on the moving belt. The belt carries the fruit to a vertical conveyer, which lifts it over the sides of a huge bin. Then floor conveyers lower it into the bin. Each bin takes the place of 240 of the older lug boxes. It is arranged in such a way as to be separate from the harvester and removable from the truck bodies.

Upon reaching the pineapple cannery the bins are lifted from the trucks by high-straddle-trucks and taken to the unloading area. Here tail gates built

FIGURE 5.—Relief, drainage, soil, intensity of production and methods of cultivation and harvesting all play important roles in the utilization of land for the pineapple crop. Within territory suitable for pineapple growing, all favorable land is planted to the crop. (Courtesy of the Hawaiian Pineapple Company.)

in the bins are opened, hydraulic lifts tip the bin and the pineapples tumble out onto automatic graders in much the same way that hydraulic coal is unloaded from trucks. Saving in time and effort are well worth the long period of experimentation that went into construction of the mechanical harvesting equipment.

Extending the Harvest Period. There are many other improvements designed for use on the plantations still in experimental stage. One such project is directed toward spreading the three-month harvest season over a longer period. It is known that use of plant hormones speed up fruit maturation to the point where some fields may be harvested weeks ahead of other fields. The idea of speeding up fruiting is not new, but use of hormones, especially in a sprayable solution, is new. A further advantage is low cost; a very small amount of the hormone liquid will, when diluted, cover acres of plants.

Speeding Up Growth. Further application of hormones can only be explained by describing some of the growth habits of pineapples. After the 18–20 month growing period has passed, and fruit has been harvested, numerous shoots are sent up by the plants. They are thinned to two per plant, and allowed to grow. They then develop fruit within about 12 months, and a second harvest from the field is obtained. The first harvest, in which there is one fruit to a plant, is called the "plant crop." The second harvest, in which there are two fruits to the plant, is called the first "ratoon" crop. The third year the plants are again permitted to produce two fruits from the shoots. This is called the *second* "ratoon" crop. After the third year, or the second "ratoon" crop, the practice has been to plow under the field and leave it fallow, or to plant it to some other crop.

Now in any year and on any field, some fruit ripens after pickers have worked the rows. By going over the fields again the slowly ripening fruits can be harvested. That is, they can be harvested from the plant crop and the first ratoon crop. But from the second ratoon crop the late maturing fruits have previously been lost, because a definite schedule must be followed in clearing the fields so that all of the

FIGURE 6.—Scarcity of workers for extensive pineapple cultivation forms a constant problem. The mechanical harvester has displaced hand pickers and greatly expedited the harvesting of the crop. (Courtesy of the Hawaiian Pineapple Company.)

thousands of acres involved can be dealt with.

It is here that the hormone plays its most practical role. By spraying the second ratoon crops with hormones the tardy fruits are accelerated, and very few, if any, fail to ripen by regular harvest time.

Soil Conservation. In 1937 the HAPCO began a comprehensive soil conservation program including contour planting and terracing of the steeper slopes. The resultant checking of erosion has been noticeable to even the untrained observer when compared with fields where the program has not yet been applied. The main objectives were to conserve top soil and to retain badly-needed moisture, especially on Lanai. Approximately ¾ of the plantation areas controlled by the HAPCO are now engaged in the conservation program, with only the last ratoon crop fields still having the pattern of straight rows.

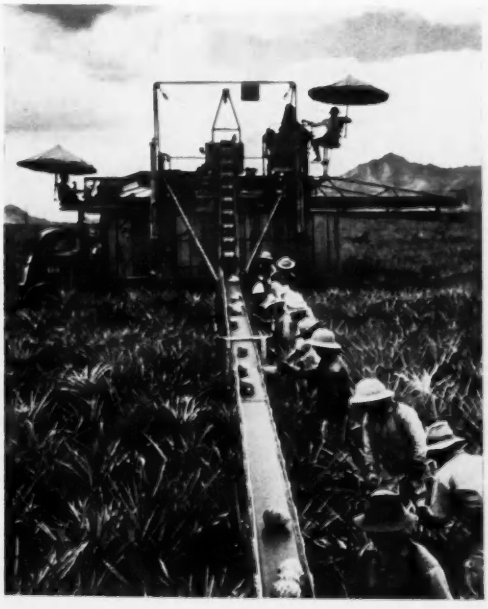

FIGURE 7.—The mechanical harvester has a long boom which swings out over the pineapple field. An endless belt runs along the boom. As workers pick the fruit they cut off the crown and lay the fruit on a conveyer belt, which carries it to a vertical conveyer. The vertical conveyer lifts it over the sides of a huge bin which holds fruit enough to fill 240 of the older lug boxes. (Courtesy of the Hawaiian Pineapple Company.)

Saving Labor in the Cannery. In a previous paragraph it was noted that fruit, when brought from the fields in the newly developed seven-ton bins, was emptied out onto automatic graders, which sort the pineapples as to size. Then endless belt conveyers transport the differently-sized fruits to huge devices called Ginaca machines.

The Ginaca machines, invented by Henry Ginaca in 1913, are continually being improved. Their main job is removing the outer shell and decoring the fruit in one swift movement. At present each machine can deliver more than 90 fruits to the trimming table per minute. Within the past few years an end attachment has been added which cuts the residue of the fruit from the shell so that this too may be used as edible pineapple. The machine also sends the shell and waste parts on to the by-product plants for conversion into citric acid and pineapple bran.

The cylinders of pineapple are fed from the Ginaca machine to the trimming tables, where thousands of girls wearing rubber gloves and armed with keen-bladed knives remove any particles of rind remaining, as the fruit slips over the rollers. From this table the fruit undergoes a water shower for cleaning purposes and then on to the slicing machines. Some of the fruit is sliced, some cut in smaller pieces and packed as tidbits, gems, spears, and crushed fruit, according to how the fruit cylinder was graded. Then it is packed in cans and the cans filled with syrup. After sugar syrup has been added to the cans and all air is exhausted from them, they are sealed, sterilized, and stored for cooling purposes. The cans are made in a factory of the American Can Co. across the street, and pass on conveyers

through an overpass into the cannery.

Utilization of Waste Products. A phase of the pineapple industry peculiar to Hawaii is in utilization of waste products. The outer shell and ends of the fruit, after being cut away from the inner pulp by the Ginaca machine, are sent on a belt to another section of the plant, where the rind is shredded and pressed. The juices coming from the press are filtered and clarified to the point where various end products are obtained. Pineapple alcohol and citric acid have been manufactured for many years as well as vinegar and carbon dioxide gas. The remaining juice, from which acids have been removed is sent back to the cannery proper, where it is used as part of the syrup immersing fruit in the cans.

The rest of the dried waste from the presses is sold as "Pineapple bran," for use as cattle feed. Local demand for pineapple bran usually exceeds the amount produced.

Mechanization in Hawaii. Owing to the high degree of mechanization at both plantation and the cannery, Hawaii's pineapple industry now boasts that the fruit is virtually untouched by human hands. During harvesting, the fruit is picked by men wearing gloves, although an occasional worker braves the prickly shell without them. Mechanically loaded into bins, then unloaded onto graders at the cannery, then fed into the Ginaca robots mechanically, then onto the trimming tables, the fruit suffers no handling up to that point. At the trimming tables the girls all wear rubber gloves while removing rind left on the cylinders. Next the slicing machine receives the fruit and more rubber-gloved girls grade the fruit and pack it into the cans, which are sealed in a press that crimps the edges. Such sanitary conditions, quality, and standardization are production features emphasized in marketing Hawaiian pineapples.

Organization for Marketing. Organization of the Hawaiian Pineapple Canners Association permitted establishment of a coöperatively supported experimental station. But sale of pineapples was a competitive field. In 1908 the market for pineapples was glutted, because few people were familiar with the canned product. After $50,000 had been raised and expended for coöperative advertising, the large stockpiles dwindled. The first world war gave increased impetus to pineapple production as profits during the period were high; but the world depression of the early thirties again found the industry with large stockpiles on hand and little demand for them. In 1932 many fields of ripe pineapples were not even harvested.

FIGURE 8.—From the huge Ginaca machines, which take off the outer shell and punch out the core of the fruit at the rate of 90 to the minute; fruit is delivered to the trimming table, the trimmings are saved, and the shell and the waste parts delivered to the by-product plants for conversion into citric acid and pineapple bran. (Courtesy of Hawaiian Pineapple Company.)

The Pineapple Producers Coöperative Association was formed to set quotas for producers. The Association soon took the place of the Hawaiian Pineapple Canners Association, and resumed coöperative advertising helped sell the surplus pineapples.

Canned pineapple juice resulted from the depression. Previously the juice was very difficult to obtain, making the cost prohibitive. The fruit cells are too small and tough to be broken down by ordinary presses. Need for variation of product promoted research on pineapple juice, and again the scientists came through with the answer. By mixing sharp quartz crystals with pineapple pulp before pressing, all the juice held by the fruit cells is released. Advertising aimed at developing interest in the juice and the new product, became successful. Since 1941 production of canned juice has exceeded in quantity production of canned pineapple.

Can Hawaii Maintain Its Lead? Can Hawaii maintain preëminence in world pineapple production in the future? Natural advantages, such as optimum climate and fertile soils, are not distinctive, or limited, to Hawaii. Nor is Hawaii the only United States territory within the Tropics. Technological and economic advantages plus experience of over forty years of continually expanding production in Hawaii are, however, factors of great importance, that any other region will find difficult to overcome. Aggressive search for better cultivation and production methods which has characterized the Hawaiian pineapple industry continues, indicating that the Islands intend to maintain their lead in world pineapple production. Advantages which Hawaii possesses over the rest of the world indicate that the Islands can dominate the trade for many years to come.

There are ominous threats, however,

FIGURE 9.—The cylinders of pineapple are fed from Ginaca machines to trimming tables where thousands of girls, wearing rubber gloves and armed with keen-bladed knives, remove any particles of rind left on the fruit, as it slips over the rollers. (Courtesy of Hawaiian Pineapple Company.)

on the distant horizon. Australia, the Philippines, Formosa, and the Singapore pineapple areas have locational advantage over Hawaii in penetrating the enormously large potential Asiatic market. In the Queensland district of Australia and in the Philippine Islands, the pineapple industry which is of recent development, was disrupted during the war: its future is difficult to forecast. Prior to the recent war, the Philippine Islands were producing large quantities of pineapples to be sold fresh both locally and on the Asiatic mainland. Owing to Japanese censorship, production data concerning Formosa is extremely vague. Production for the areas, however, has been estimated as accurately as possible from incomplete data available, and shown in the table of production. Puerto Rico, although having most of the advantages of Hawaii, needs capital and industrial "know-how." Puerto Rico's position as a territory of the United States, with the several advantages such position carries with it, may attract the capital needed; but Hawaii's lead and experience of more than forty years of continually expanding production will be even more difficult to overcome. There have been known cases where fresh pineapple from the West Indies has been labelled by Eastern fruit dealers as "Hawaiian" in order to gain the benefits of Hawaiian advertising, despite the fact that Hawaii annually ships but a few thousand cases of fresh fruit to the mainland, and none of them reach Eastern markets. Cuba, although at present the second largest pineapple exporter, has the disadvantages of tariff restrictions erected by the United States and other countries, and suffers from relatively unstable political and economic conditions. Until they can be eliminated, Cuba will not become a serious rival of Hawaii's position.

Hawaii, then, may safely assume that during the next decade her leadership will be maintained, but that potential threats may materialize into real threats to her position from that time on.

THE BROKEN COTTON BELT

Franklin C. Erickson

THE Cotton Belt is generally described as an area occupying greater part of the southern states wherein geographical conditions are suitable for growth of cotton from which a large percentage of the agricultural population derives some or most of its cash income. Though the idea still persists in the minds of many, and may be true to a limited degree, great changes in land economy of the South have taken place within the past twenty-five years to require qualification of the further use of the expression Cotton Belt with qualifications.

Basic geographic factors which have made cotton production possible in the area still endure, for the most part unchanged. The conversion in land economy of the South, which has taken place, is largely result of economic factors and to lesser degree social and political causes.

Cotton was a Southern crop in Colonial days, generally planted for home use. As a hand industry, preparation of raw cotton for spinning and weaving of cloth was a slow, laborious task and as long as it remained in this stage, small acreage of cotton sufficed to meet needs of the people. A series of inventions, the spinning-jenny, the loom, and the cotton gin changed production of cotton cloth from a hand to a machine industry. Accompanying the transformation in the textile industry, an ever increasing demand for raw cotton was created and acknowledged by Southern planters with increase in cotton acreage. Cotton proved to be a profitable crop and before long it had established itself in the agricultural economy of the Southeast and was expanding rapidly in acreage at expense of other crops. From the Old South, cotton production started moving west taking over choice lands wherever it went—into the New South, onward into the Deep South and at a still later date into the irrigated areas of the Southwest and California.

During the Civil War the South was unable to raise very much cotton. The whole economic fabric of life in the South was changed and cotton production did not regain its dominant position until 1878. From that time on, cotton acreage continued to increase throughout the South wherever physical conditions were suitable for its growth and where irrigation could be used, until it reached its greatest expansion in 1927 when slightly less than 45 million acres were devoted to the crop.

Up to the time of the Civil War, slaves had been used on large plantations in production of cotton, but with abolition of slavery the South was faced with two major problems; Negroes who needed jobs to make a living, but who were without money to buy or rent land, and land-owners who had plenty of land, but were without money to pay wages. Solution of the problems led to sharecropping, a system of rental still common in many parts of the South. A sharecropper pays rent for his farm with a part of his crop, instead of with cash. In this way, the originally large plantations were divided into a great number of small tenant farms. Cotton is raised on the tenant farms, with a mule and few tools.

In eastern Texas and Oklahoma where the land is divided into many small

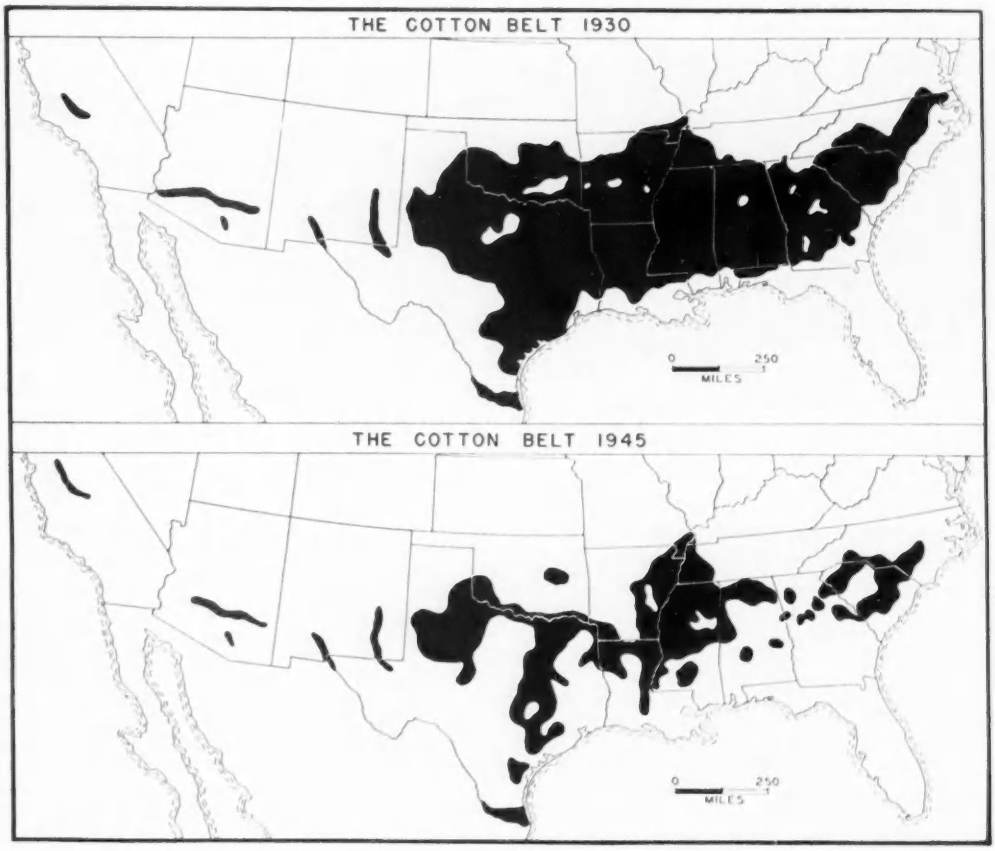

FIGURE 1.—Comparison between almost continuous areal distribution of cotton growing in 1930 in the so-called Cotton Belt, and disrupted and broken distribution of the same crop in 1945, indicates a profound transformation of land utilization and farm economy of the region in the period of fifteen years. The Cotton Belt has apparently been broken into fragments, so far as growing cotton is concerned. Cotton has lost its sovereignty over much of the area in a decade and a half.

farms cotton is grown in much the same way as in the Southeast.

In the delta region of the Mississippi, Louisiana, and Arkansas, in the Great Plains area of Texas and irrigated areas of Arizona, New Mexico and California the farms are large and level, and lend themselves to large-scale methods of production impossible in many parts of the southeast. Where the crop is raised by hand, a farmer and his family do not plant more than ten to fifteen acres, whereas by machine methods a farmer can handle a hundred or more acres.

While acreage devoted to cotton since Colonial times has generally increased for the Cotton Belt as a whole, there have been fluctuations in cotton acreage and production as result of weather conditions, the effect of the boll weevil and fluctuation in price. In many cases production of cotton has not been profitable, for too many tenant farmers were depending on the crop, which naturally led to overproduction and consequent lowering in price.

From 1910 to 1930, acreage of cotton has varied from about 28 to 45 million, while production has varied from 8 to 18 million bales. Average annual acreage devoted to cotton for the years indicated

FIGURE 2.—A Cotton Belt practice of many years' standing, cultivating cotton with mule and plow prevails over much of the scattered fragments of the old Cotton Belt, but the region is becoming increasingly mechanized.

has been around 35 million with production of about 12 million bales, more than sufficient to meet domestic and foreign consumption, so that there has always been a world carry-over of American cotton amounting to 5 or 6 million bales. The surplus of cotton production and general world conditions have caused the price of cotton to fluctuate widely, from 7.4 to 35.2 cents per pound.

Campaigns for reduction in cotton acreage were carried on in 1905, 1915, 1921 and 1927 in the hope that reduction in acreage would bring about a necessary reduction in supplies and reserves and stimulate the price of cotton. The campaigns were conducted by individual farmers and farm groups without Federal Government participation and without much success.

In the early 30's world consumption of American cotton averaged 12 million bales, but production had been 15 million bales or more, creating an annual carry-over of 3 million bales. In August 1932, world carry-over of American cotton was 13 million bales, and production that year was 13 million bales, giving a total supply of 26 million bales of American cotton. The price of cotton in 1932 averaged only 5.7 cents per pound and sold for as low as 4.6 cents.

Overproduction or underconsumption, with accompanying low prices in practically all agricultural enterprises at this time prompted passage of the Agricultural Adjustment Act on May 12, 1933. Part of the Act applied to cotton.

FIGURE 4.—Picking cotton by hand is tedious, back-breaking work. It still remains the dominant method throughout much of the old Cotton Belt, where, as yet, a mechanical picker has not proved successful either technically or economically.

FIGURE 3.—Over wide areas of the old Cotton Belt still remaining, "chopping cotton" on small farms is still a family affair. As in the cultivation of cotton, so in the chopping of cotton, mechanization is increasing on the areas left.

The Cotton Adjustment program was an effort on the part of producers and the Government to improve the economic status of cotton producers by adjusting supplies of cotton to demand and maintaining balance between supply and demand. Each cotton producing state was given an acreage allotment amounting to certain specific percentage of its previous cotton acreage.

Several of the southeastern states had

already reached their peak in cotton acreage before passage of the Cotton Control Act so that with its enactment, the region's cotton acreage declined rapidly.

Cotton allotments for the years 1938–1942 for the entire United States amounted to about 27 million acres annually. The government agreed to pay a parity commodity price or bonus to farmers who would agree to plant soil-building or nitrogenous crops such as beans, vetch, clover, and lespedeza. In this way acreage diverted from cotton to planting of nitrogenous crops for the five-year average 1934–1938 amounted to over 11 million acres. It is interesting to note that while the cotton acreage allotment for the years 1938–1942 was about 27 million, actual acreage for the same years was about 3 million less. Other crops were substituted for cotton with favorable results, and they now seem firmly established in the land economy of the South.

For a century or more world consumption of cotton has fluctuated with peace and war, with prosperity and depression, yet the long-time trend has been upward. Our cotton production economy has been based on the fact that our annual domestic consumption amounted to about 6 million bales, while the annual foreign consumption of American cotton has also been 6 million bales. Whenever combined domestic and foreign consumption fell below 12 million bales we had to accumulate a carry-over or stockpile.

We have been, and still are, the greatest producer of raw cotton in the world, but other producing countries have stepped up their production, causing general increase in total world cotton production. In some instances foreign lands produce their cotton more cheaply. The combined results have caused a falling off in our cotton export trade which in turn has increased our carry-over. Thus it was that our carry-over in 1938 amounted to about 11½ million bales.

Actually the Cotton Control Act was not wholly effective for, in spite of controlled acreage, production of cotton remained relatively high. The situation was created when marginal cotton land dropped out of use and improved methods of cotton culture were employed on the better lands.

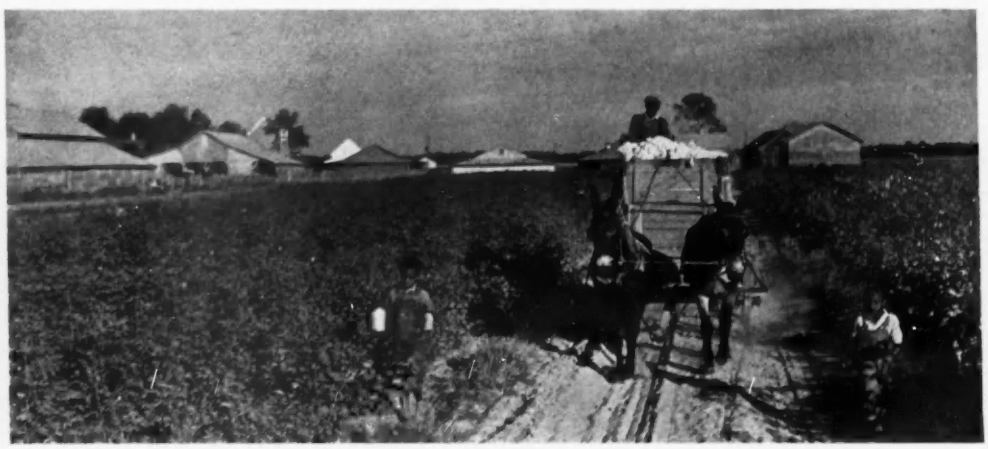

FIGURE 5.—Hauling cotton to the gin in the ordinary farm wagon with high sideboards, and drawn in most cases, by a team of mules, persists over wide areas where cotton is still grown within the old boundaries of the Cotton Belt.

War in Europe in 1939 just about suspended our export trade, but we continued to send some cotton as lend-lease aid and greatly increased our own mill consumption to supply our armed forces. During the war the world's annual cotton crop shrunk some 3 million bales, but in 1944 the world's stock of cotton amounted to some 24 million bales. With cessation of hostilities foreign countries again stepped up their cotton production to about 5 million bales more than in 1939. Also, present consumption of world cotton is about 24 million bales, or 4 million bales below the prewar rate. World stocks on hand in 1945 were close to 26 million bales.

Before the war the United States held the bulk of the world cotton surplus, but now every other exporting country of importance has an unprecedented surplus.

FIGURE 6.—The modern four-row cultivator is being operated over ever-increasing expanses of the broken Cotton Belt. To compete with other areas of important cotton growing, like Brazil and Turkestan today, the old Cotton Belt must employ more and more machinery.

Former efforts of the United States to uphold the price on American cotton made it easy in some years for other countries to undersell us abroad. The challenge was met by passage of the Surplus Property Disposal Act whereby we can export cotton at competitive prices. Cotton producers in the United States have been dependent on price-supporting measures. Cotton became

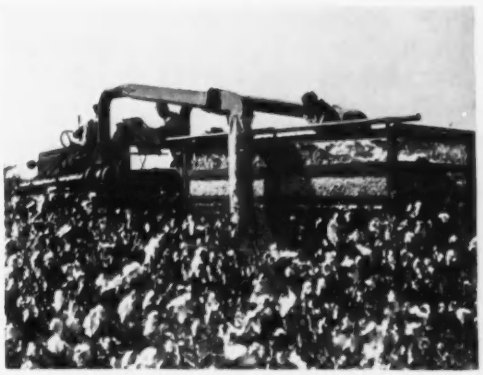

FIGURE 7.—The mechanical picker, of which the use is constantly expanding throughout the areas of the Cotton Belt, particularly in the West, insures reduction in the cost of growing cotton successfully that has helped to maintain cotton growing in certain parts of the old Cotton Belt.

one of the most heavily subsidized of all United States crops. The farmer was protected by a non-recourse government loan, which guaranteed him an average price of 21.09 cents per pound no matter what cotton's real value or world price would be. The law will not expire until three years after the President proclaims official end of the emergency.

Combination of economic and political factors have placed cotton producers in a hazardous position. Our country cannot forever carry on price-supporting measures for any crop and cotton is no exception. The only way that better incomes for producers of cotton can be insured is through lower costs of production; and any area or region which cannot make the necessary adjustments may lose its present position to areas which can. Good cotton farmers average a bale per acre, but the national average is held down by marginal farmers who merely plant and pray. Some 75 per cent of the farms in the southeast produce less than eight bales of cotton, and average yield per acre is about six-tenths of a bale.

Further improvements in cotton pro-

duction such as use of selective seeds, scientific fertilization, topping of plants and boll weevil control can be improved by farmers in all parts of the South. However, soil preparation and cotton cultivation by mechanical power already in use in some regions of the South can be used to better advantage in some areas than in others.

Regions which seem to hold the favored position of future cotton production in the United States are the Southern High Plains and the Mississippi Delta Region where large farms and level land permit the use of machinery, and irrigated lands of New Mexico, Arizona and California.

The map of cotton acreage for 1945 shows that the Cotton Belt is no longer a belt, but consists of a few large areas of cultivation held together by narrow bands, with several small outliers.

Perhaps cotton remains "King" in the South as a whole, but if so, its realm has been greatly reduced in size, and scattered.

HISTORIC FOREST FIRES IN MAINE

Charles B. Fobes

DESTRUCTIVE forest fires in Maine during October 1947 ravaged more than 200,000 acres of forest land, destroyed 1,182 homes, 280 barns and 1,193 other buildings. Fifteen persons lost their lives while scores were injured. The financial loss was between twenty-five and thirty million dollars. The losses were greater than in any previous disaster. In the past, forest fires have swept over large areas in Maine and, while not destroying as much man-made properties as the recent fires, have brought destruction to large quantities of merchantable timber, young growth, and seedlings. Severe forest fires change character of the soil, reduce regularity of stream flow and kill wildlife. Park or recreational forests are rendered unattractive and useless thus defeating the purposes for which they were established.

Since the economic development and history of Maine is closely bound to her forest resources, any student of Maine history or geography would do well to acquaint himself with a few pertinent facts concerning outstanding early forest fires and the present Maine State Forest Service organization that maintains a program of active fire prevention, detection and suppression program. The following paragraphs will serve as a convenient reference to facts surrounding early fires that are now spread through histories, reports, and bulletins often difficult to find. Details of the 1947 disaster will be omitted because widespread accounts of the holocaust may be found in recent newspapers and magazines.

Original Forest Growth

When the first settlers came to Maine, the whole area was covered with a luxuriant growth of hardwoods and softwoods. The southern half of the state west of the Penobscot River was predominantly occupied by northern white pine, either in pure stands, or more often, mixed with hemlock, red oak, white ash and other hardwoods. The remainder of the state was mostly covered with spruce and fir and northern hardwoods. Hardwood species such as sugar maple, yellow birch, and beech were usually found on well drained ridges while softwoods preferred poorly drained flats and rocky higher elevations. It is worth noting that with possible exception of Mount Katahdin all mountains of Maine were well forested to the very summits. Barren mountain tops today in Maine may be attributed to past forest fires—fires that destroyed both vegetation and soil. Some of the devastated areas have never been able to form a soil deep enough to restore a forest covering. Fires, however, were few in the original forests for they were set only by Indians and lightning. As pioneers began to clear wooded areas for agricultural purposes, fires increased in number and extent to change markedly even the character of the original forest. Where softwood species were destroyed, they were replaced by light seeded hardwoods such as aspen, grey and white birch and cherry. Indeed, range of the white birch in Maine can be traced in many sections directly to past forest fires.

EARLY FOREST FIRES

Earliest settlements in Maine were concentrated in the southwest part of the state (see ECONOMIC GEOGRAPHY, January 1944) and it was here in 1762 that destructive fires ravaged the forest. It is interesting to note that the 1947 fires swept in part over the same area as the early fires; however today the area is more thickly populated and loss of homes was far greater. Williamson writes in a History of Maine—"Early in July 1762 devouring fires did immense damage to the woods of New Hampshire and spread into Maine. They burst forth from the woods of New Hampshire and burning with irresistible fury passed through Towah (Lebanon) and being driven by the winds to the eastward entered Scarborough, Gorham town, and New Casco (Portland) and to the neighboring forests where they raged until they were only checked by a flood of rain which fell on the 19th and 20th of August. Even the cattle in many places did not escape the violence of the devouring fire. A vast quantity of the most valuable timber was destroyed besides houses and sawmills." Perley states in "Historic Storms of New England": "On the seventh of July, a fast was held at Falmouth, in Maine, on account of the drought, but the services were scantily attended, as the men were busy in putting out the numerous fires that prevailed all through the locality, because of the dryness of the earth and vegetation." In the last statement it is noteworthy that the word "fires" is modified by "numerous." Forest fires that cause high property loss and cover extensive areas are usually result of not a single fire, but more often overlapping or uniting of many separate fires. This fact was observed in the Minnesota forest fires of 1918. The York-Cumberland county fires of 1947 and also the 1762 fire were similar in this respect.

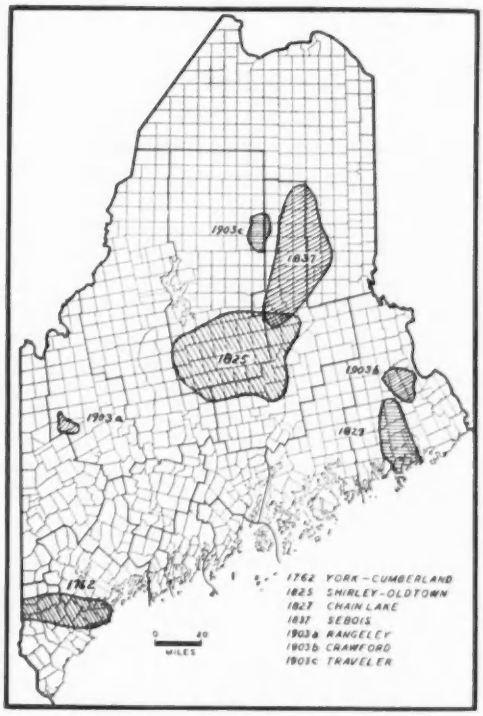

FIGURE 1.—Areas devastated by historic forest fires in the State of Maine, not including the holocaust of 1947, in which 200,000 acres of forest land were burned and 1,182 homes, 280 barns, and 1,193 other buildings were destroyed, with a financial loss of more than twenty-five million dollars. In earlier fires, the major part of the loss was of large quantities of merchantable timber, young growth, seedlings, and broad areas of fertile arable soil.

At the time of the 1762 fire, the southwestern section of Maine was enjoying the benefits of the "King's Mast Trade." Defebaugh states: "Interest in the development of the lumber industry of eastern Maine was directly due to the great forest fires which ravaged New Hampshire and swept over the western part of the present State of Maine in 1761 and 1762. Living as they did, in the forest and very largely depending upon the forests for their means of livelihood, a considerable portion of the inhabitants of the ravaged section removed beyond the Penobscot in search of the forests to take the place of those

that had gone." Historical records reveal that inhabitants of Black Point, Scarborough, in particular, explored possibilities of new sawmill sites in eastern Maine and were responsible for settlement of Machias, beyond the Penobscot watershed.

The most extensive fire in Maine history that has been rather definitely located (Figure 1) is often confused with

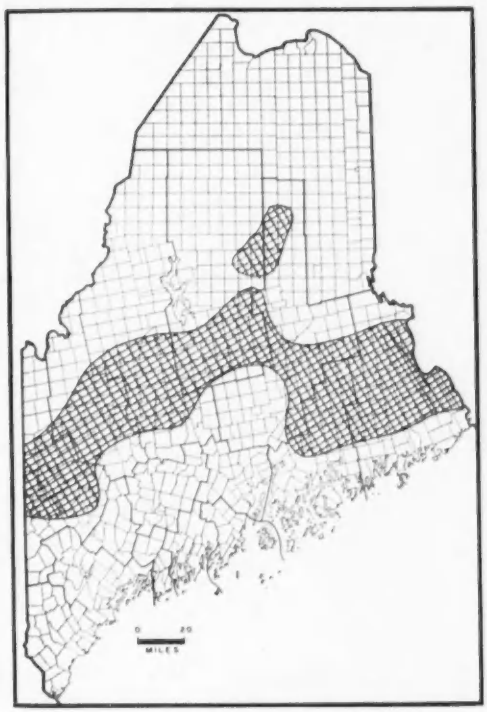

FIGURE 2.—Range of commercially important white birch, which has been repeatedly damaged by serious forest fires of historic record.

the Miramichi fire of New Brunswick that burned at nearly the same time. The Miramichi fire burned from the town of Newcastle, New Brunswick, in October 1825 along the Miramichi River valley covering 3,900 square miles or 2,500,000 acres of forest land, destroying 590 buildings, 1,000 head of livestock and bringing death to 160 persons. It was the most destructive forest fire of all time in the East. An important factor in prevalence of large forest fires is drought. August and September, 1825 were extremely dry in Maine. Settlers with no law to prevent them, burned slash and stumps on land they were clearing. Many small fires smouldered in the Shirley-Elliotsville area of Piscataquis county, then the pioneer fringe of the state. On the seventh of October of that year a violent north to northwest wind swept northern Maine. The small fires soon raged out of control; the fire spread rapidly and travelled southeastward through parts of Guilford, Medford, Parkman, and Ripley. Turning slightly eastward it crossed the West Branch of the Penobscot River below Twin Lakes and finally reached the main stream of the Penobscot and burned south along the western bank to the vicinity of Old Town. This Maine conflagration compared with the Miramichi fire; as much as 1,300 square miles or 832,000 acres of land were devastated.

In 1837, human carelessness resulted in a 234 square mile burn. The fire, named the Sebois, was started by a man who set fire to a large pile of hay on the meadows along the Sebois River. Spreading northward the fire passed over a section of the previous fire of 1825 and terminated in southern Aroostook county. (See Figure 1.) Research indicates that the 1825 and 1837 fires brought about a marked change in the original forest growth from softwood to hardwood. The resulting forest type has meant establishment of the hardwood industry in the same general area. The present commercially important range of the white birch, an important tree in the hardwood industry is shown in Figure 2; it is interesting to compare its range with the location of the large forest fires of the past. Although the hardwood industry has brought prosperous conditions to many towns, transition from the original softwood growth

to the present hardwood type has taken nearly 100 years.

Combined effects of lumbering, fire, and development of the blueberry industry in southeastern Maine (Washington county) has changed the original appearance of thousands of land. Extensive sand plains were originally covered with a mixed growth of hardwoods and softwoods, especially white pine. After removal of the choice lumber, destructive fires destroyed the remaining growth. Then when canning blueberries became a profitable industry more sandy areas were burned each year so the blueberry bushes would be free from grass and weeds. Careless management of early spring blueberry land burning has caused extensive fires in Washington county.

Forestry District Established

From the standpoint of forest fires, 1903 was a destructive year in Maine. In that year 345 fires burned 267,587 acres and financial loss rose to $947,588. By this time, timber had become less plentiful and the public came to realize that everyone loses when forests burn. The Land Agents who had been appointed by the Governors of Maine from 1820 to 1891 had little authority to administer any forest protection program, but with creation of a Forest Commission and designation of the Land Agent as Forest Commissioner by the state legislature in 1891 a definite conservation plan was started. In 1909 an act was passed that established the Maine Forestry District; the act levied a special tax of 2¼ mils on each dollar valuation of property within the wild land area of the state. The tax is used solely for preventing, controlling, and suppressing forest fires within the district. In 1946 the Maine Forestry Department received $134,934 from the tax; the amount was matched by Federal funds. In order to achieve an effective organization, the 10,000,000 acres of woodland under care have been divided into four sections. Each is handled by a supervisor who in turn has chief wardens in sub-districts; the smaller divisions usually conform geographically to stream watersheds.

Forest Protection Program

The Maine Forest Service was the first in the country to use lookout stations as means of detecting forest fires. Mr. Elmer Crowley who believed that most forest land could be surveyed from fixed elevated positions was the first man to establish a forest fire lookout in Maine. It was placed on Big Squaw Mountain in the Moosehead Lake area, in 1908. Today there are 95 lookout towers in

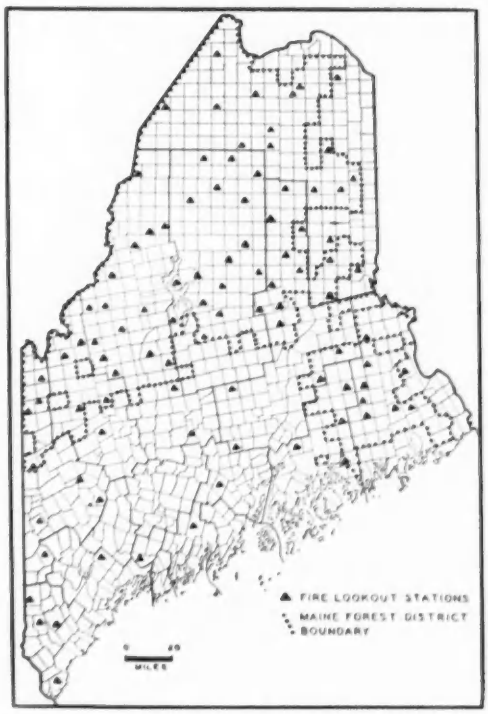

FIGURE 3.—The Maine forestry district of which the boundary is indicated in the map was created by Act of the Legislature in 1909, when a special tax was also levied to support protection against forest fires. Numerous fire lookout stations have been provided. The State is divided into four major sections, which include most of the ten million acres of woodland.

Maine (see Figure 3). Airplanes were used for detection purposes for the first time in 1927; at the present time, three planes are used by the service. The pontoon-equipped plane is ideal for the work in Maine where there are so many inland water bodies. Planes reach fires quickly, especially fires left by campers along shores of lakes.

When the state began to assist municipalities outside the Maine Forestry District in 1930, a separate division was formed, called the Organized Towns. The division is under management of a supervisor who coöperates with selectmen of towns seeking help. Today there are 18 towers that overlook 65 per cent of the 6,683,000 acres of forest land in such organized sections.

An important part of the Service is devoted to entomology problems. Many surface fires only scorch the outside layers of a tree, but deep enough to kill the tree. Insects prey upon standing dead timber soon after a fire. The State Entomologist is able to offer advice on treatment of newly burned areas and also aids in control of insect infestations that cause losses even greater than those by fire.

SUMMARY

The original spruce-fir and northern hardwood growth that once covered the State of Maine has been scourged by forest fires since white men made their first settlements about 1630. Carelessness in times of severe drought has been the main cause of disastrous fires. Not until about 1903 did landowners realize that something must be done to prevent and control fires in timber. In that year the Maine Forestry District was established and since then an efficient well-balanced forest protection program has been maintained. Forest fire losses are now kept at a minimum in the wild land and organized towns, but with greater population today than in the early history of the state constant surveillance and protection are needed.

EUROPE'S CRITICAL FOOD SITUATION

Ralph E. Birchard

ALMOST three years after end of hostilities in Europe, the food situation there remains crucial. According to the estimate for 1946–47 of the Food and Agricultural Organization of the United Nations (FAO), only people of Denmark, Czechoslovakia, Eire, and Sweden were consuming 95 per cent or over of their prewar calorie intakes. At the low extreme, people of Austria, Germany and Rumania were getting only 80 per cent or less. Residents of remaining European countries consumed between 80 per cent and 95 per cent of their prewar amounts. The figures refer to urban populations. Farmers, even in countries hardest hit, still consume as much as, or more than, they did before the war. Low levels of consumption have caused higher mortality rates, increased disease and decreased per capita work output which acts as one of the major causes in retarding industrial and general recovery.

The situation is expected to continue through 1948, 1949, and perhaps 1950. At the Paris Cereals Conference, held July 9 1947, it was estimated that world importing countries would need about 50 million tons of grain, in the 1947–48 consumption year, with only about 32 million tons available from surplus areas. Needs were pared by the FAO to from 34 to 38 million tons as necessary to hold consumption levels of 1946–47 and possible supplies were estimated from 30 to 34 million tons. It is believed that even with a bountiful grain harvest in 1948, it will not be possible to abandon bread rationing in all countries.

What are the reasons for this situation? What is their relative importance? Those are problems that must be solved.

The Prewar Status

To understand thoroughly the present situation in Europe the prewar picture of food production must be studied. In doing so it is immediately found that present conditions to quite an extent are due to levels of production prevalent for some time. Due to dense population in relation to available land, food production for many countries was insufficient to feed the people. Varying degree of sufficiency or surplus is shown in Figure 1. In general countries of the Northwest with exception of Denmark, were least self-sufficient while those of the East had largest surpluses. The balance for Europe as a whole demanded that about 10 per cent of the calories for consumption must be imported.

Greater deficiencies in the west were due to greater density of population, much more industrialization and consequently higher urbanization, rather than lower efficiency. In fact agricultural efficiency was much higher in least sufficient countries as shown by much higher yields and greater food production per person. Under such conditions countries of the Northwest were more sufficient than might have been expected and the East produced less surplus than it was capable of doing. On the other hand, the advantage was offset by the fact that peoples of the Northwest consumed more food per capita

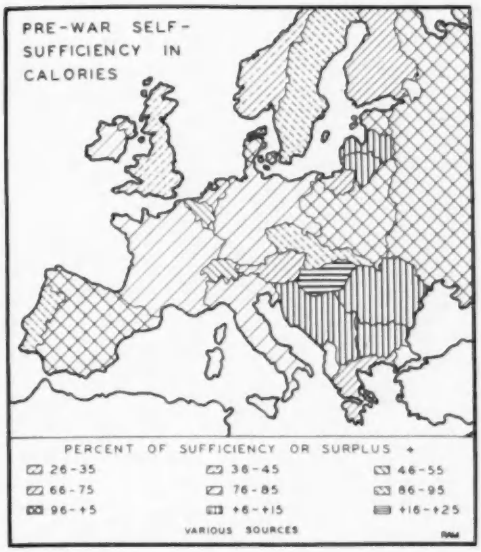

FIGURE 1.—The countries of the Northwest and Italy had the greatest food deficits in Europe before the War. In Germany, 83 per cent self-sufficient as a whole, the Western Zones of Occupation, Figure 3, were estimated to have only 60 per cent prewar self-sufficiency. Note that no country had a rating of 56 to 65 per cent, so it is omitted from the legend.

than those of the South and East. Peoples of the Northwest were more efficient and enjoyed a higher standard of living.

Another important prewar factor in the sufficiency of food production was agricultural emphasis. Most countries of the Northwest engaged in intensive production of livestock and livestock products, even importing feedstuffs in order to do so. In the other areas, livestock was raised extensively or neglected. Relatively, the consumption of meat and cereals was just reversed—the peoples of the Northwest were high meat and low cereal consumers, while those of the other areas, the East especially, were high cereal and low meat consumers. The French, greatest cereal consumers in the West, consumed less cereals than peoples in the East.

Prewar status of European food production gave the least self-sufficient countries a better chance to improve their position than those of the rest of the region. In the first place they could lower their per capita intake to a greater degree without serious effect upon health and productive capacity of the people. In the second place they could liquidate part of their livestock and thus release some cereal food for human consumption, plant pasture and fodder land to human food crops, and shift from feed imports to food imports. Livestock numbers decreased in all countries during the war but to a greater degree by plan in the Northwest where the countries not ravaged by war (or at least until near its end) substantially increased their acreages in food crops as shown in Table I. Such changes lowered the quality of diets, but did raise total food production. Even with such changes, however, most deficit countries found it impossible to become self-sufficient at prewar consumption levels. The present critical situation, therefore, emanates largely from the prewar status of food production. It has been aggravated, of course, by war, postwar confusion, and unfavorable weather conditions, and has been emphasized by inability of needy countries to pay for supplies for their needs.

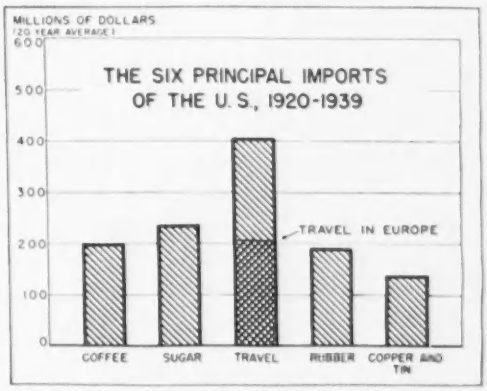

FIGURE 2.—Tourist travel was the biggest "import" of the United States, 1920 through 1939. European countries were credited with just over one-half of the dollars from this source. (Graph from *Foreign Commerce Weekly*, May 10, 1947.)

TABLE I

BASIC FOOD CROPS[1]

(Thousands of Hectares)

Country	1936–38 Ave.	1939	1942	1943	1944	1945
Group I: Countries Increasing Hectarage During the War						
Belgium	487	357[2]	506	526[3]	491	424
Bulgaria[4]	2,374	2,368	2,598	2,668	2,650	2,506
Denmark[5]	353	344	308	387	388	372
Eire	241	243	424	391	447	446
Netherlands	518	504	649	679	631	518
Norway	90	96	133	134	125	117
Portugal[4]	1,349	1,328	1,503	1,681	1,834	1,791
Sweden	663	647	694	664	636	624
Switzerland	137	144	184	208	206	204
United Kingdom	1,155	1,124	1,740	2,189	21.29	1,725
Group II: Countries Losing Hectarage During the War (Same Years as Above)						
Austria	908	846	703	689	675	.....
Finland	444	399	339	355	367	370
France	8,197	7,523	6,468	6,453	6,464	6,988
Greece	1,282	1,340	.....	.....	.....	1,068
Hungary	3,714	3,788	3,437	3,543	3,483	2,814
Italy	8,510	8,672	8,508	8,549	7,692	7,403
Poland[5]	9,535	.....	.....	.....	.....	5,526
Rumania[4, 6]	10,676	11,385	6,809	8,979	10,632	10,380
Spain	6,873	5,883	6,308	6,148	6,049	.....

[1] Wheat, corn, rye, potatoes, and other vegetables. Although food crops (especially vegetables) vary for different countries only those with comparable data for a country for the whole period were used.

[2] Single underline—lowest hectarage for the period.

[3] Double underline—highest hectarage for the period.

[4] Lowest hectarage in 1940.

[5] Both figures are for present area.

[6] Includes rice which accounts for most of the recovery after 1942. ——Figures not available.

Source: *International Yearbook of Agricultural Statistics*—1941–42 to 1945–46 (Volume III), International Institute of Agriculture, Rome, 1947.

REASONS DUE TO THE WAR

To evaluate aggravation of the food problem consequent upon war, causes have been divided into physical, economic and political effects, discussed henceforth in that order.

Physical Effects.—An important physical effect of the war was to prevent use of some land—either temporarily or for several years. Some of the principal reasons were layout of additional airfields, building of fortifications, erection of obstacles, placing of land mines, pattern bombing, and inundation. Other factors of the same kind, affecting production and distribution, were slaughter of animals, wrecking of transportation facilities, and loss and crippling of manpower.

An indication of the land rendered useless in several countries is shown in Table I, although part of the change may be due to other factors. The figures show that the countries in which actual ground fighting took place are affected most. The greatest sufferers

were France, Italy, Austria, Greece, Poland, Hungary, Finland, and Spain. Spain's decrease resulted from her own Civil War, of course, and probably resulted more from other causes than physical effects. Although comparable figures for Czechoslovakia, Yugoslavia, Germany and the Soviet Union were not found, there are some statistics on Germany and the Soviet Union. Our government has published the facts that Germany used 3.2 million acres less of farm land (mostly plowland) in 1939 than in 1933, even with return of the Saar. Military purposes took a considerable part and the rest lay idle. The Soviet Union had about 40 per cent of its prewar cultivated acreage occupied at the height of the German push. Regaining that, it added large areas from its neighbors. Even so, its grain production last year, a favorable one, did not reach prewar amounts. Food production has apparently ceased to be critical there, however, although some difficulty in distributing it to urban centers still continues.

Importance of the various effects cutting down usable land in the other countries is difficult to ascertain. New airfields and fortifications were built in most countries and took some land from cultivation, even in countries where acreages were increased. No doubt, France and Italy lost more through mining and bombing than any of the others. The two, with Belgium, the Netherlands and Germany were heavy losers through building of fortifications and erection of obstacles. The Netherlands, of course, lost most heavily from flooding, about 540 thousand acres of her land being inundated. Of this area, even the 190 thousand acres covered with salt water, has almost been brought back to full production.

The relative importance between food and draft animals killed during the war is different. Food animals killed in fighting were probably of relatively little consequence since large numbers were slaughtered purposely to release more vegetable food for human consumption, Table II. On the other hand, displacement and depletion of draft animals still continues to have important effects. A few countries have more horses than they had before the war, but most of them have fewer. Countries for which we have statistics had only 80 horses in 1945 for every 100 before the war as shown in Table II. Loss of both draft power and machinery means more hand labor for producing equal quantities of food. Decline in the United Kingdom follows their replacement by tractors but in other countries the same cause does not operate.

TABLE II

INDEX NUMBER OF LIVESTOCK 1945

(Average 1935–1938 = 100)

Country	*Horses*	*Cattle*	*Pigs*
Austria	106	87	36
Belgium	111	93	60
Bulgaria	92	70	63
Czechoslovakia	90	88	64
Denmark	115	102	52
France	72	91	62
Greece	64	59	49
Hungary	34	37	32
Italy	79	85	74
Luxembourg	87	101	59
Netherlands	116	84	50
Norway	111	91	41
Poland	31	31	14
Roumania	56	86	50
United Kingdom	78	108	49
Yugoslavia	43	46	47
Average	80	78	50

Source: *Preliminary Report of the Temporary Sub-Commission on Economic Reconstruction of Devastated Areas*, United Nations, Official Records of the Second Part of the First Session of the General Assembly, Supplement No. 3, London, 29 July–13 September, 1946.

Crop yields, for which figures are available, declined in all countries but did not prove so decisive a factor in the breakdown of German economy as anticipated. Now, however, fertilizers to build up soil, and pesticides to protect

crops from insects, are urgently needed, having been neglected for several years. Needs are particularly great as livestock numbers are low and prewar amounts of barnyard fertilizers are not available.

Destruction of critical foci in the transportation network, and of rolling stock, have caused difficulty in distribution of food and commercial fertilizer, of which most countries on the continent have felt direct effect. Most of the network is usable again and railway freight traffic in almost all European countries exceeded the prewar level in mid-1947. However, more repairs and greater replacement will be required for several years than was normal before the war.

Economic Effects.—Several economic conditions, consequent upon the war, have profoundly affected food surpluses of the world and Europe's ability to buy needed supplies. They are discussed as (1) the changed pattern of world food production, (2) low industrial production in Europe, (3) low gold reserves and dollar credits in Europe, and (4) inflation in both Europe and the United States.

The changed pattern of world food production constitutes an important factor. The war lowered food production in Asia as well as in Europe. Before the war Asia exported food to Europe. Now the surplus producing countries of Asia are not able to supply any food to Europe and Asia as a whole must import. Moreover exports from one of the largest prewar food exporters to Europe, Argentina, declined over five million tons in 1947, as compared to prewar. Decrease from Australia, due to a poor crop year, accounted for another two million tons. Such results followed, in some measure, changes in production during the war because of the loss of the continental European market, although trade with the United Kingdom continued. Probably Argentina will not become so great a grain exporter again as before the war, because of her higher per capita consumption and her mounting population.

Low industrial production has importance in ability to raise food, power to purchase it, and chance to distribute it properly. Shortage of farm machinery and even lack of spare parts for used machinery that could be repaired causes decline in food production. Limitations imposed on German industry have been one of the chief causes of the situation as Germany ranked as one of the most important prewar producers of farm machinery. With little consumer goods on the market, farmers have little incentive to produce as large surpluses as possible or to sell such surpluses as they have. In turn this makes rationing necessary, or the ration smaller than otherwise necessary and, with the consumer goods shortage, also greatly lowers the industrial worker's incentive. Contributing to lower industrial production is dearth of labor, especially skilled labor, because so many men who would have been getting training were in the services. In addition low levels of food consumption have retarded production in some localities, most apparent in the Ruhr where the poor food situation is given as a reason for setback in coal production in 1946.

Low industrial production and accumulated local needs means little goods available for export. It consequently serves a reason for low gold reserves and dollar credits and inability of European countries to finance purchases of food and other supplies needed from abroad. Other factors accounting for low gold reserves and dollar credits include loss of returns from foreign investments, loss of merchant marine tonnage and deterioration of facilities for taking tourists. Some foreign investments were liquidated to help carry on the war while others were cut off during

the war and have revived only slowly. Examples of the latter are Far Eastern tea, rubber and tin and African cacao, palm oil and minerals. Countries losing most on such products are the United Kingdom, the Netherlands, France and Belgium.

Merchant Marine transport was another important source of prewar earnings for some European countries. Earnings from shipping accounted for more than 30 per cent of Norway's merchandize exports and were also very important in foreign exchange for the United Kingdom, the Netherlands, Denmark, Greece, Italy and Sweden. The European fleet tonnage was reported early in 1946 to be barely 60 per cent of prewar although world tonnage increased during the war. The greatest expansion was by the United States. Tonnage of most European countries has been brought close to, or slightly above, the prewar level by intensive building and purchase of United States surplus vessels. Increased activity with fewer ships in certain cases has increased earnings. On the other hand some American vessels built for war use have proved expensive to operate for most peacetime traffic.

Tourist travel was America's biggest "import" from 1920 through 1939, Figure 2. Money spent by Americans abroad for services, food, lodging and goods built up more dollar credits than imports of sugar, coffee, rubber, or copper and tin. Slightly over half the tourist dollar credits were for European countries. Most countries have been able to accommodate since the war only a limited number of tourists as compared to the prewar period so they have not been able to take full advantage of that "export." Dollar credits are particularly important to Europe at the present time because the United States has more supplies that Europe needs than any other country. The credits are almost impossible for Europe to build up as she has very little goods the United States wants and Europe is not in position to furnish prewar services.

Inflation in both Europe and the United States aggravates the situation. In Europe incentive is further lowered by inflation and low real value of the currency. The loan to Britain would have been much more effective if prices had remained steady in the United States. According to the "Atlantic Report" of the *Atlantic Monthly* of September, 1947 the loan lost 30 per cent of its negotiated value in nine months, consequent upon price rises in this country.

Political Reasons.—Several political conditions difficult to evaluate have affected and are affecting, food production. Confusion in agriculture caused by war and policies imposed by occupation forces, great migrations of people, the Russian policy of keeping large occupation armies which feed off the land, the "Iron Curtain," land reforms, Communist-led strikes, division of Germany, and low levels of production imposed upon her. The main effects of the first have been discussed except that building up of livestock numbers reduced during the war forms an added strain on postwar production and imports.

Movement of peoples about Europe has had very important effects upon the production and distribution of food. The United States Government claims that about eight million people (mostly Eastern Europeans) were forcibly displaced by the Nazis. By early 1946 about seven million were repatriated by the Western Allied Armies. A few more than a million, who refused to go home, are called displaced persons or DP's and were left in Germany (850,000, of which over 500,000 are in the United

States Occupation Zone), Austria (148,000) and Italy. Some have been taken, and are still being taken by countries of Northwestern Europe, but most remain in camps and draw upon food supplies or imports of the food deficit countries.

No doubt much more important than the DP's disruption of production and distribution are the additional millions of people who moved varying distances on their own initiative.

The continuing refugee problem in Greece is cited here as an example of the effect on a single country. According to Harry N. Howard writing in *The Department of State Bulletin* of March 7, 1948 more than 400,000 people (mostly farmers) from northern Greece have had to flee because of guerrilla warfare. He further states that in November 1947 it was noted that only about 25 per cent of the cereal crop could be harvested. Besides this about 40 per cent of the potato crop was lost and also large numbers of livestock. Not only was food lost that the refugees had produced but it has become necessary to feed them. They overflow facilities of the cities and caused a breakdown in food distribution.

While the Russian army may have been discharging troops of late, news reports indicate that many of those discharged have been given civilian status in the countries in which they were stationed and will still eat there. There has been much speculation as to the effect of the "Iron Curtain," Figure 3. It is to be expected that economic ties and trade will be much greater between Eastern European countries and the Soviet Union than formerly but that outside trade will not be eliminated. If food remains a surplus item in the East it will be available but, no doubt, at high cost in exchange for materials Russia needs. On the other hand it is conceivable that the agricultural system will be changed to such an extent that grain will not be an exchange item and Western Europe will have to depend permanently upon other sources or lower the quantity and quality of her import.

Land reforms reflected in division of large estates have affected the most land in Hungary, Poland and Yugoslavia. In many cases new acreages, reported too small to be practical, form part of the collectivization scheme. The other Russian policy, Communist-led strikes, causes loss of production and waste in distribution in front of the "Iron Curtain." France and Italy have had their economies injured most by strikes.

EUROPE 1937—1948
--- BOUNDARIES CHANGED SINCE 1938 — POSTWAR BOUNDARIES
OO THE IRON CURTAIN TERRITORY CEDED BY TREATIES
TERRITORY CHANGED DE FACTO 1938-1947
PAPTICIPANTS IN ECONOMIC COOPERATION AND AID FROM THE UNITED STATES
VARIOUS SOURCES
RAM

FIGURE 3.—Europe has become split along the "Iron Curtain." This line also separates the great deficit food areas on the west from the surplus producers to the east. The "participants" in the Marshall plan are being aided in their recovery by the United States.

Division of Germany and the Russian policy of withholding food from her zone (which normally produced surplus food) to the western zones (normally deficient in food) has meant provision of more food

by the western occupiers, namely: the United States, the United Kingdom and France. In turn the amount that can be furnished other needy Western European powers is reduced. Limitations imposed on production in Germany have retarded industry in all of Western Europe and have had repercussions on agriculture. Now that the German level of industry has been raised in the Western zones and she probably will be accepted as one of the "participants" in the European Economic Co-operation program (Marshall Plan) she can do her part. If enough help is provided in time by the United States the participants will recover and much faster than without aid.

REASONS NOT DUE TO WAR

Two factors not attributable to war have further aggravated the food situation. First, the increase in population. The rate has been changed by the war but was normally increasing for most countries and thereby making necessary more food. Secondly, poor weather for crop production, which would have called for more food imports and caused some discomfort, but not the significance that its added impact gave to postwar problems.

Population Factor.—When per capita consumption levels remain steady, increasing population lowers self-sufficiency or cuts into the surplus production of a region or country. The prewar status of food self-sufficiency in Europe was due in large measure to overpopulation of the available food producing land. In 1947 there were about 20 million more mouths to feed than in 1938. Increase was greatest in the East, lowering surpluses available from that region, and in Italy. Rate of population increase has been slowing down in the West and has become negligible in France.

The over-all effect, however, is need for more imports from outside. All countries figure their present and future needs according to prewar consumption levels and will surrender such standards only slowly and reluctantly. Increased needs of the United Kingdom for cereals from 1939 to 1947, following increase in population and at the prewar per capita cereal consumption levels, was an additional 31 thousand bushels. Hungary at her prewar cereal consumption level needed almost 17 thousand bushels more, thus cutting down the surplus that much from that country. In any case of population increase import needs of the region are increased. For the two countries cited the regional import needs in cereals increased by 48 thousand bushels.

Another pertinent population factor is the rural-urban ratio. Farmers, of course, reserve plenty of food for themselves before selling. With little consumer goods and high prices they have little incentive to sell except on the black market. Therefore most of the rural population consume as much as they did before the war, or more. Urban population then suffers most and greatest percentage of urban dwellers live in the industrialized West and in Italy. It constitutes only one more of the many factors causing greater than normal food deficit in the West.

Weather Factor.—Two crop years since the end of the war have suffered adverse weather conditions for crop production. The spring and summer of 1945 were drier than usual and, naturally, crop production declined. Italy, one of the countries hit hardest, had her small grain production reduced by a third. Bad weather followed in the winter of 1946 and 1947 and the following summer (1947). Temperatures dropped exceptionally low during that winter and destroyed and damaged much winter

wheat. With lack of seed of the right kind for spring seeding and summer drought, French wheat production fell off one-half, and Europe's food grain production declined by 200 million bushels. All such production losses charged to weather drew further upon the world's meager food supplies, strained collection and distribution systems and caused greater financial reserve depletion and more indebtedness. The adverse weather of 1946 and 1947 is considered by the Committee of European Economic Co-operation as "the straw that broke the camel's back" and caused the setback in industrial production and general recovery of Europe.

SUMMARY

Throughout the study some of the reasons for the critical food situation in Europe have been emphasized in relation to others. The factors considered of prime importance in explaining the situation are: (1) inability of the land to produce enough food for people of the countries of Northwestern Europe; (2) destruction of Western Europe's means to finance necessary foreign purchases of food and raw materials; (3) particularly difficulty in building up dollar credits and reluctance of the United States to provide means for doing so; and (4) migrations of many people.

Other important factors, contributing to, or aggravating the situation, are: (1) changed world food production pattern; (2) division of Europe by the "Iron Curtain"; (3) physical destruction; (4) increasing population; (5) adverse weather conditions; and (6) lowered incentive to sell farm surplus.

LOCATIONAL FACTORS AFFECTING INDUSTRIAL PLANTS

Francis E. Elliott

THIS paper will develop what is believed to be a new approach to the problem of plant location. Ideas here presented simplify the complicated procedure in analysis currently used by economists and statisticians. The approach is also well suited for geographic analysis because it is adapted to map presentation. Time does not permit elaborated details, but it is hoped that the basic premise will become clear. Consequently all examples cited in this paper are extreme, exaggerated cases, because it is believed that they convey the ideas best for purposes of illustration.

While the writer was trying to work out several locational projects, i.e., the malt industry, a barber shop, and a millinery shop, he realized that all factors influencing location of a particular enterprise can be arranged into two groups, which will be called *constants* and *variables*. Constants are factors which are determined by circumstances beyond control of the particular industry or plant. Variables are factors that can be controlled or modified, and made to fit the individual need.

At this point the argument may be advanced, that modern technology can make all factors variables. Climate can be changed by air conditioning, or materials can be flown into regions which cannot be reached by other means of transportation. Theoretically a man can produce steel at the North Pole by flying raw material in and finished products out, but the cost of such a means of transportation would make it a hobby and not a business. However, we are dealing with business; and further, we are trying to find the place on the surface of the earth where a man's enterprise will be more profitable because of locational advantages than at any other place on the earth.

Keeping this aim as the prime objective, it is believed that two items will determine which of the factors influencing the location of a plant will be variable or which will be constant, in each individual case. The two items are (1) amount of expected business, which will be called *volume;* and (2) difference expressed in dollars and cents between cost of accumulated raw material and sales value of the finished product which will be called *value added by manufacture*, although this definition may not be the same as that used by the Bureau of Census.

How the two items determine variability is shown in two examples as follows:

1. Let us assume that U. S. Steel decides to erect a plant with an annual output of ten million tons of steel, at a point with high transportation costs. The volume of the plant and the fact that U. S. Steel is capable of creating its own transportation system can force the carrier which serves the chosen point to reduce its rates. Thus transportation becomes variable for U. S. Steel. John Doe, who processes one thousand tons of steel a year and does not have the same volume as U. S. Steel, cannot force reduction in rates, and transportation is constant as far as he is concerned. U. S. Steel can build its plant at a point which is suitable for other reasons, de-

spite original high transportation costs; whereas John Doe, if he cannot afford to pay the high transportation rates, will have to move to a point that offers cheap transportation, if he wants to stay in business. Therefore, transportation may be a variable in one case and a constant in another.

2. Climate is variable for an industry which has a high value added by manufacture, such as the Glenn Martin aircraft plant in Baltimore. The summer climate in that place is warm and humid enough to reduce efficiency, but the value added by manufacture is sufficient to permit air conditioning of the plant in order to compensate. However, climate is invariable for the malt industry, for instance. The maximum temperature of 70° F. is required in the germination of malt. If the temperature gets too high, growth is too rapid and the maltster loses too much weight and extract by too strong sprouting; the high temperatures also kill most of the diastatic power essential to the finished product. Value added by manufacture in this industry is small; therefore cost of air conditioning would reduce value added by manufacture to a point where production of malt would cease to be a profitable business. Therefore, again, climate may be a variable in one case and a constant in another.

Constants and variables work the same way to determine market pull or raw material pull. Once more, two extreme cases are cited to illustrate. An industry processing ubiquitous raw material and selling its product to a restricted localized market will find that raw material is variable, but market is constant; consequently it will be market bound. On the other hand an extractive industry processing an ore confined to a narrow area, but selling its product on a nation-wide market, obviously has a variable market and a constant raw material base; it is raw material bound.

Labor is a difficult factor to evaluate. With the advance of division of labor in modern industry, skill decreased in importance. Furthermore, modern transportation and changing sociological patterns have made labor mobile. If the assumption is made that labor will be efficient and have little tendency to strike if given fair pay, good equipment, and pleasant working conditions it may be classed as a variable. Thus a plant can be built at a place with a generally low efficiency rating and a bad strike record, provided that the location is otherwise advantageous. Citing an extreme again, it is supposed that workers can be made sufficiently interested in the prosperity of a plant that they will be efficient and non-striking, if a profit sharing plan, old age retirement, paid vacations, etc., are initiated and carried through. Ideological reasons for labor unrest are disregarded because they are incalculable.

The few examples cited here show that the pull is toward the constants; and the technique to be followed in a locational problem becomes essentially clear. In an actual case, a list of all factors of importance should be made by studying manufacturing processes, marketing, labor requirements, etc. Then it should be determined how much leeway the volume, and the value added by manufacture will permit. Leeway, in case of value added by manufacture, is that amount which is not taken up by fixed production costs and anticipated net profit. Careful analysis of each factor on the list will determine the variables and the constants. Geographical distribution of the constants should make it easy, then, to eliminate all regions, areas, or even cities, depending upon what level the analysis is based, which do not satisfy conditions involved. For instance, an industry using large

amounts of water will hardly find a desert area suitable.

Proper evaluation of relative importance of the variables, and their application to remaining territory, should enable the investigator to reach, by continued process of elimination, a location which offers a workable compromise.

The process of elimination can be accomplished cartographically by blacking out on a map all unsuitable areas. This can be done on one map, or on separate maps for each individual item. In either case, the desirable areas will then show up in white and the best location can be found in the manner described.

LAND FORMS AND LAND USE EAST OF MONTEREY BAY

Charles Noble Beard

TERRAIN on the eastern shore of Monterey Bay presents excellent opportunity for correlation of land forms with types of land use. Field investigation of land forms and their probable means of origin was made by the writer during the years 1938 to 1941, and again in early 1947. Reconnaissance surveys of distribution of crops and general land use were made at the same time. Statistics of crop production compiled by the county agricultural commissioners of the counties of Santa Cruz and Monterey also have been of value. Information thus obtained reveals general utilization of land forms along with outstanding trends which result from combinations of economic and geographical factors.

The district studied extends from the city of Salinas on the south to the vicinity of the eastern suburbs of the city of Santa Cruz on the north and extends inland for about 15 miles to the margin of the Santa Clara Valley amid the Coast Ranges. It comprises plains areas about the mouths of the Salinas River and the Pajaro River, along with relatively low sections of coastal mountains adjacent to the river valleys.

Principal Land Forms and Soil Types

Eight major groups of land forms may be recognized and mapped on the eastern shore of Monterey Bay (Figure 1); principal characteristics and probable origin of each are readily determined.

Along the shore line, beaches are well developed throughout the entire region. Adjacent to the beach there is usually a wall-like mass of dunes rising to heights of 50 to 100 feet. The "wall" forms a topographic barrier between ocean beaches and alluvial plains of the rivers which debouch upon the sea (Figure 2). In some instances, however, prevailing winds have carried dune sand up onto higher levels, such as elevated marine terraces, and dune areas extend several miles inland and individual summits reach elevations of 500 feet or more above sea level (Figures 3 and 4). Soil of the dunes is generally of very poor quality even when it is fixed in place by vegetation, and little use may be made of the land.

Fringing the sea and distributed around the outlets of the streams are uplifted terraces, classed by geologists as Quaternary Terraces, which apparently originated by marine planation and have since been elevated above sea level either by diastrophism or by eustatic changes of the strand line. Excellent examples of this land form may be seen at Capitola at the northern edge of the district and just south of the mouth area of the Pajaro River (Figures 1 and 5). Evidence pointing toward the marine origin of the terraces is afforded in the vicinity of Capitola where they form extension of the same elevated bench which west and northwest of Santa Cruz has generally been mapped and described as marine terraces. Direct evidence of marine origin is given by deposits of magnetite sand, found on the inner margin of a terrace about five miles west of Watsonville, similar in composition to a modern beach sand near by. Marine terrace

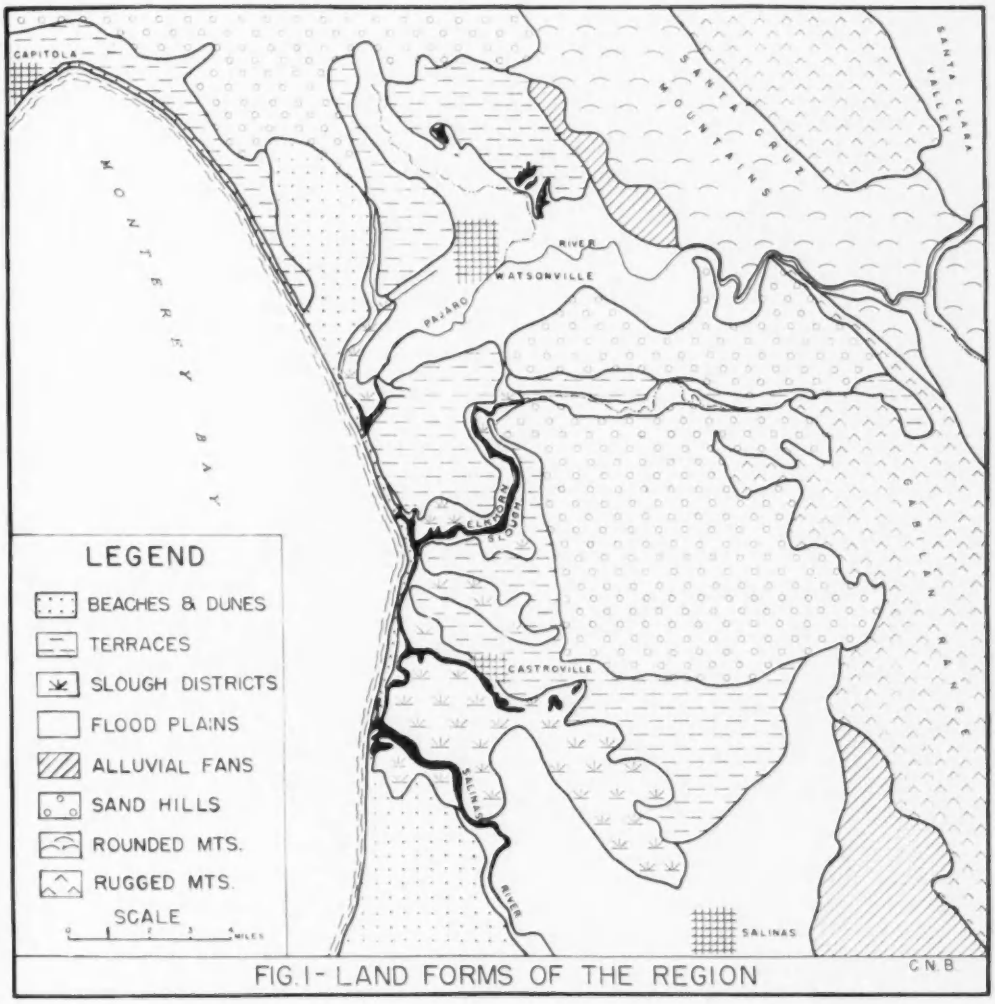

FIGURE 1.—There is wide diversity in the land forms that constitute the terrain on the eastern shore of Monterey Bay. Corresponding diversity in soil types, and land use are consequent upon the varied land forms.

soils are composed of sand, loam, and clay of medium fertility. Comparable terraces, evidently formed contemporaneously, extend inland along sides of the larger stream valleys, such as the eastward extension of Elkhorn Slough valley (Figure 6). The terraces seemingly are due to former erosion and deposition of the streams while at higher levels. There might also have been elevation of the Coast Ranges which helped give the benches higher situations.

Slough and marsh districts are found at the mouth areas of the large stream valleys, notably the Salinas River, Elkhorn Slough, and the Pajaro River (Figure 7). At the Salinas River, such topography extends four to five miles inland. Origin of the slough and marsh districts was mainly by alternate cut and fill of the streams accompanied by filling-in by vegetation and other means. Wet and peatlike soils abound, and in many places large percentages of the districts are covered by water of the sloughs. Fertility is high, but use is

limited because of the high amount of moisture.

The alluvial fan, another land form, is in many places formed where small streams flow down from the mountains onto lower land. Conspicuous examples of this land form are found along the base of the Santa Cruz Mountains east of Watsonville (Figure 8). Fan soils have high fertility and are used ordinarily for intensive agriculture or high-value orchard crops.

Flood plains of major streams of the region form considerable expanses of level lowland which contain soils of exceptionally high fertility (Figures 5 and 9). Examples which account for large percentages of the total area are Salinas River plain, Pajaro River plain, and Elkhorn Slough valley. The soils are best of the entire eastern shore area and are devoted to intensive agricultural and horticultural production, particularly production of apples.

Extensive regions composed of low hills, mostly of sand and rarely of gravel, are located west and northwest of Watsonville and east and northeast of Salinas. Technically the hills are situated in foothills of the mountains, but because of their low elevations and distinctive bush and scrub vegetation, they are preferably separated and called Sand Hill Districts. The hills are developed in soft sedimentary formations, usually of marine or littoral origin. Cross-bedding of ancient sand dunes may be observed in many places. Fertility of the soils is low, and erosion is a grave problem.

An additional land form is that of well-rounded mountains of moderate elevation developed on soft marine and continental sediments of sand, gravel, and clay (Figure 10). Landslide topography is relatively common because the San Andreas Fault or Rift Zone traverses the area, along with several parallel fault zones of considerable magnitude. The principal area of this land form is in the Santa Cruz Mountains east of Watsonville. Soils are infertile, and little use for crops is attempted; consequently pasture and timber land prevail.

The last land form noted consists of rugged mountains of moderate elevation (maximum elevation of 3,169 feet) developed on resistant, well-consolidated sedimentary, metamorphic, and igneous rocks. Development is chiefly in the Gabilan Range south of the Pajaro River, but there is one area formed on rocks of the Franciscan formation which lies north of the Pajaro River along the

FIGURE 2.—Beach and adjacent coastal dunes about five miles west of Watsonville. Sloughs may be seen in the left background of the view.

west side of the Santa Clara Valley (Figure 1). Soils of the mountains are so infertile and water is so difficult to obtain, that pasturing is about the only use that is attempted.

MAJOR CROPS AND PRODUCTS OF THE REGION

Fruit Crops.—Major fruit crops on the eastern shore of Monterey Bay are, in order of acreage, apples, grapes, apricots, cherries, and pears. Apples are by far most important and constitute the outstanding crop; grapes and apricots occupy moderate acreages; and cherries and pears are relatively minor crops.

Value of apple products of all kinds for Santa Cruz County in 1946 was estimated at $5,265,000, and most of the production was near Watsonville. There is comparable production on the south side of the Pajaro River in northern Monterey County. No definite allocation of apple orchards to any one land form may be observed, but the most favorable location for apples is proved by production per acre to be on the stream flood plains such as the Pajaro River plain, where yields of 1,200 to 1,500 boxes per acre are often obtained, whereas on poor soils of sand hill districts and in mountain foothills yields are commonly as low as 100 to 150 boxes per acre.

Grapes grown in the region are mostly wine grapes, principally along the northeast shore of the bay in the Sand Hill Districts. Total acreage of the crop in Santa Cruz County in 1946 was only one-ninth that of apples.

FIGURE 3.—Coastal sand dunes resting on Quaternary Terraces near the mouth of the Pajaro River.

Apricots follow grapes in acreage and are similar as to location, for the trees are generally planted on sloping and hilly land of the Sand Hill Districts and on the foothills of the mountains. Total value of the crop is usually no more than about one-twentieth of the value of the apples of the region.

Cherries are localized in an area east of Capitola. Acreage is small, but value of the product is relatively high ($554,000 in 1946).

Pears of a hardy export type are grown in a small area north of Watsonville. World War II cut off the market for the fruit, and canners took the pears and found that they had desirable canning properties.

Berry Crops.—Remarkable increase in acreage and production of berry crops, principally bushberries, has character-

ized the last three years in the vicinity of Watsonville. Intensive development of the frozen food industry, especially during World War II, has stimulated expansion in acreage. Many new fields have been planted in the dunes area west of Watsonville, where berries are usually grown without irrigation (Figure 11), and notable increases have also taken place in terrace districts and sand hill regions. Gross returns of $1,000 or more per acre are not uncommon. However, curtailment in contract amounts to about one-third of the 1946 production took place in 1947 due to a much smaller demand.

Vegetable Crops.—Principal vegetable crops of the area are represented in approximate order of acreage by lettuce, tomatoes, artichokes, Brussels sprouts, broccoli. Among them, lettuce stands pre-eminent; it has average value of three to four times that of any other vegetable product.

Lettuce is produced in spring, summer, and fall crops, often in succession on the same tracts of land. Fields of lettuce are planted almost exclusively on the best soils of the region, and production as to land forms can be definitely allocated for most of the acreage to stream flood plains and alluvial fans. Rich alluvial soils of Pajaro River valley and Salinas River valley are especially well known for concentration of lettuce fields. Value of the lettuce crop of Santa Cruz County for 1946 was estimated to be $3,861,000, and value of the lettuce crop of Monterey County (of which most of the production occurred near Salinas) for 1946 was estimated at $23,944,810.

Brussels sprouts and tomatoes are grown ordinarily on about the same type soils as lettuce. Sprouts are much in demand by frozen food processors, and tomatoes are taken in large quantities by canners.

Slough lands appear to be the best type for artichoke production. Slough districts in the vicinity of Castroville, the self-styled "Artichoke Center of the World," and similar areas near the mouth of the Pajaro River have major concentration of the crop. Some fields are planted on the marine terraces in the vicinity of Castroville. In 1946, there were 4,000 acres in the Castroville district planted in artichokes.

Broccoli, which depends for a major portion of its market upon the frozen food industry, is produced in considerable quantities on terraces, stream flood plains, and alluvial fans of the Monterey Bay region. Most fields devoted to

FIGURE 4.—Recent sand dunes capping Quaternary Terraces near Capitola. A typical terrace surface, probably of marine origin, lies in the foreground and centerground.

broccoli at the present time are in northern Monterey County.

Cauliflower is a vegetable crop of the region formerly was of considerable value but which has suffered great decline in acreage recently. The year 1946 was time of maximum production of the crop in the Monterey Bay area, when 830

FIGURE 5.—Profile view of probable marine terrace (background) and lettuce field on the Pajaro River flood plain near Watsonville.

acres were devoted to it in Santa Cruz County and 500 acres in Monterey County. However, great losses to growers in 1946 due to fluctuation in demand by frozen food establishments caused the 1947 acreage to be cut drastically. Cauliflower, under normal market conditions, usually competes with lettuce—for the best land on the stream flood plains and the alluvial fans.

Field Crops.—Field crops of most importance in order of value are sugar beets, hay crops, and dry beans.

Greater part of the sugar beet acreage is found on stream flood plains and alluvial fans. Comparative prices of beets and lettuce often determine which will be planted on certain tracts. That beets are grown mainly on a contractual basis helped increase acreage of the crop in 1947 because lettuce has been subject to marked price fluctuations.

Hay crops are grown on poorer soils of nearly all land forms represented, but major concentration has been on marine terraces and in foothills of the mountains. The leading hay crop is oats, but alfalfa and other legumes are grown in places.

Dry beans are grown in scattered fields all over the region, and no concentration on any one land form could be determined. However, field observations and conversations with the Agricultural Commissioner of Santa Cruz County make it clear that within the last few years, dry bean acreage has made a high percentage increase, particularly in the Watsonville to Castroville area, comprising southern Santa Cruz County and northern Monterey County.

Dairy and Livestock Products.—Dairy farming and livestock production are common in the entire area, but usually the marginal or sub-marginal land of the mountains and the Sand Hill Districts is given over to them. Pasture lands and hay fields which furnish feed

FIGURE 6.—Prominent stream terraces along a valley which drains into Monterey Bay.

for stock are extensive in foothills of the mountains. A rather surprisingly large percentage of the acreage of the Quaternary terraces west and southwest of Watsonville is utilized for dairy farming; it is probable that more intensive use of the land could easily be made, but a reconnaissance survey showed that

FIGURE 7.—The central portion of Elkhorn Slough, bordered by lands which are classified as slough and marsh districts.

often lettuce rejects from the nearby packing sheds forms an important diet item; this locational factor might easily outweigh any increased crop value that might be derived from more intensive land use.

CONCLUSIONS AND FUTURE PROSPECTS

Crop Correlation According to Land Forms.—In the region studied, general use of each land form may be ascertained, and in addition it is possible to find concentrations of certain crops or products on specific land forms, thus indicating there especially favorable factors for production.

Beaches and coastal dunes are used largely for summer homes, recreation, and pasture; but recent great increases in dunes areas planted in bushberries are evident. Increased acreage seems to be accounted for by rather fertile sandy soil of the dunes, where frequent fogs minimize the need for irrigation, and increased demand for berries in the frozen food industry.

Marine and alluvial terraces are utilized mostly for hay, grain, pasture, and orchard; but small fields of berries,

FIGURE 8.—An alluvial fan along the south side of the Pajaro River flood plain. It is now planted in bushberries, but formerly was devoted to apricot orchard (about 1941).

vines, and truck crops are becoming more abundant. The principal difficulty in expanding acreages of the last mentioned group seems to be lack of water for irrigation.

FIGURE 9.—Truck farming and orchards on the Pajaro River plain seven miles east of Watsonville.

Much arable land of the slough and marsh districts appears to be especially adapted to production of artichokes, possibly because of the peat-like character of the soil; but other truck crops such as tomatoes, beets, and lettuce also are important.

Alluvial fans and stream flood plains contain the best land; and are used mostly for orchards, lettuce, beets, and tomatoes. Acreages of any one of the crops may increase or decrease rather quickly, because prices may vary and one or more products may be considered better economic risks. For example, young apple orchards are planted on fans and flood plains with the ultimate aim of replacement of truck crops for the reason that apples produce well on such soil and a good price may generally be expected for the fruit (Figure 12).

Sand hill districts have very poor agricultural land and are generally covered by pasture and brush; but there are some orchards, vineyards, and berry fields. It is noticeable that orchards do not do well on the sandy soils; and

FIGURE 10.—Low, well-rounded ridges and foothills of the Santa Cruz Mountains about five miles east of Watsonville. The apricot orchard shown in the left centerground found this environment unfavorable.

FIGURE 11.—Fields of bushberries which have recently been planted on the coastal dunes along the eastern shore of Monterey Bay.

in the mountain foothills several miles east of Watsonville many apricot orchards have been abandoned because of poor growth.

Mountainous districts of both well-rounded and the rugged types have high percentages of pasture and timber lands, but in the foothills regions numerous fields are used for hay crops and orchards.

Future Prospects.—Products of several land forms of the Monterey Bay region appear to be static insofar as types of crops and acreages are concerned, but products of other land forms are subject to annual changes in kind and amount. Market prices, consumer demand, and adaptability of land forms to various crops appear to be principal governing factors for products of the land forms which have great fluctuation.

Land forms which are comparatively static with respect to products and land use are slough and marsh districts, Quaternary terraces, sand hill districts, and both types of mountains.

Land forms which have considerable fluctuation as to products and land use are coastal dunes, alluvial fans, and stream flood plains. Increases in bushberries and truck crops have been noteworthy in the past few years on the coastal dunes. Alluvial fans and stream flood plains, which are practically alike with respect to soils and general land use, usually have numerous fluctuations in acreages and types of crops from year to year. Lettuce, sugar beets, and orchards are ordinarily the most important crops, and compete for the use of the land.

Future utilization of the land will probably be greatly affected by the frozen food industry, which is relatively important in the Monterey Bay region. Increase and decrease in acreages of several crops, such as berries and cauliflower, can often be assigned to changes

FIGURE 12.—Young apple orchard on the alluvial soil of the Pajara River plain east of Watsonville. Lettuce and other truck crops may be grown on the soil until the trees attain considerable size.

in demand by the freezing establishments. Berry plantings of recent years have used lands which usually are of little value for other crops, so it remains to be seen how much permanent production can be maintained. Apricot production probably can be expanded somewhat, with orchards located mostly on marginal and sub-marginal land, since the frozen food industry uses the fruit to some extent and thereby provides additional market.

"HIGH FARMING" IN THE NORTH OF ENGLAND 1840-1880

G. E. Fussell

NORTHUMBERLAND

THE sixty years prior to 1840 had marked vast improvements in farming of Northumberland, where John Grey of Dilston had played a yeoman part in work of reclamation and reaped a nobleman's harvest. Lord Ernle waxes more than usually picturesque about this county saying[1] that Grey "the Black Prince of the North" lived in the midst of the agricultural revolution. "When his father first settled in Glendale, the plain was a forest of wild broom. He took his axe and like a backwoodsman, cleared space on which to begin his farming operations. The country was then wholly unenclosed, without roads or signposts. Cattle were lost for days in the broom forests. The inhabitants were as wild as their home. . . . But the character of the soil was such as to attract skill and industry. Men of the same stamp as Grey, or the Culleys, settled in the fertile vales and by their spirited farming transformed into cultivated land wide districts, like the rich valley of the Till, which before the period of the war prices were wildernesses of underwood."

Cobbett[2] who passed through the county in 1832 remarks upon the enormous farms between Morpeth and Hexham on one of which he saw one hundred stacks of wheat in the yard and not another house within a mile or two, the country appearing to be almost wholly destitute of people; but very fine fields of turnips, of both sorts, in rows, kept exceedingly clean and so on. He did not think well of the cattle he saw.

The fact is that by 1840 the improved farming of Northumberland and of the Lothians was considered a pattern for all England, an honour shared then only by Lincolnshire. Turnips and artificial grasses, the beginning of improvement, had been introduced about 1780. Threshing machines had been adopted sooner than elsewhere and buildings improved. The best district in 1841 was from Whittingham by Wooler to the banks of the Tweed. From Waxworth to Berwick was a wheat and bean soil. The farms were, as Cobbett had remarked, large, ranging from three or four hundred acres to a thousand or even twelve hundred and some had mountain pasture in addition. The famous Northumberland five course rotation was generally practised, and the succession of crops was oats, turnips and a few potatoes, spring wheat and barley, clover and other grasses mown and grazed the second year. On poorer soils seeds were left down for three years. Bone manure was generally applied to turnips and grass seeds were sown with the drill.

Wheel ploughs had never been used in the country, and then (1841) the improved Scotch iron swing plough drawn by two horses were common. Corn drills were not in general use. Lime was applied once in ten or fifteen years at 160–240 bushels an acre, and if the experiments proved favourable nitrate of soda would be used as a top dressing. Horses were light and nimble

THE OLD SHORTHORN COUNTRY

"When you reach that fine country on both sides the river Tees you are then in the centre of the short-horned breed of cattle."—GEORGE CULLEY, 1786.

FIGURE 1.—According to George Culley, writing in 1786, "when you reach that fine country on both sides the River Tees, you are then in the center of the shorthorn breed of cattle." Durham and Yorkshire have produced some of the finest of that breed of cattle. From: Journal Royal Agri. Soc. of England 1899. By permission of the Society.

and Shorthorn cattle introduced by the Culleys had ousted others, although on poor rough land Highland heifers were crossed with a Shorthorn bull. There were no dairies in the north of the county. The sheep in the hills were improved Cheviots, the wethers being fatted at three years old and the ewes being sold to Yorkshire at four and fatted thereafter one more lamb. The new Leicesters were general on the lower pasture and were fatted on turnips.[3]

The new Leicesters had been introduced about the turn of the century and the Blackfaces had declined in numbers although their improved carcasses were liked at Smithfield for the London market because they resembled Southdown and Welsh mutton. A cross between the new Leicester and the Cheviots was popular,[4] and by 1870 this cross, known as the Barmshires or Border Leicesters was rapidly becoming stable. These sheep were good milkers and the farmers would often offer a choice of "yow or cow" when cheese was put on the table. By this time rapid maturity, or sufficient maturity to meet a change in taste, was effected and the wether hogs were sold not later than 14 months old, the ewes going to the fairs after three crops of lambs unless bought direct off the farm by dealers.[5]

Not all the farming in the county was done on the splendid scale described but on these great farms guano was used by 1847 and cake was fed. The middle and south was cropped on a system of fallow, wheat, clover or beans, oats, as was prescribed by the soil, and the high unenclosed hills of the west remained great sheep walks wholly given up to Cheviots. Between Wooler and the Tweed were the Leicesters. Few potatoes were grown, supplies being obtained from Cumberland by rail and from Scotland by ship. The Durham Shorthorn was, as Grey had said, preferred on the great farms but a miscellany of other sorts was to be found elsewhere.[6] A large group of other evidence recorded in the decade between 1840 and 1850 confirms all this and adds some slight details. John Chrisp mentions that lime was spread with a drop drill on turnip land. George Heppel Ramsey, the Vice President and founder of the Newcastle Agricultural Society sold an annual bill of £20,000 worth of bone dust, ground in his own mill, to farmers in all parts of the county. Caird complained of the poor condition of the family farms be-

tween Newcastle and Warkworth and the undrained land indifferently stocked in the south of the county.[7]

Enterprising men like the great farmers of Northumberland could not fail to see the advantages of steam cultivation immediately that became possible and by 1867 there were four sets in private hands, on the farms of J. Wilson, Woodhorn Manor, Morpeth; of S. Langdale, High Epsley near Morpeth; of David Wright of Beal; and on the estate of Lord Vernon of Widdrington. A few years later the tenants of the Duke of Northumberland, whose farms ranged from 300 to 500 acres, agreed that if the Duke bought a set and did their work for them at a reasonable price they would employ him as a contractor and this arrangement proved quite satisfactory.[8]

By this date, however, some of these men had decided that the trend of prices indicated that grazing would in future pay better than arable farming; or if not quite so definite, that a large proportion of their land should be given up to grazing because of the more remunerative prices of stock and the "increased cost of labour." Amongst these were Sir Edward Blackett, Bart. of Halton Castle Farm near Corbridge who laid down 222 acres of his 530-acre farm in the decade 1865–75. He first drained where necessary and covered in the oat stubble in autumn with lump lime at 12 tons an acre, and cleaned the land in spring for turnips heavily manured with 15–18 cartloads of rotten dung, two cwt. guano and three cwt. superphosphate. Half the turnips were fed off, half were drawn and in the following spring the land was worked down to a fine tilth and the grass seeds sown. "Sutton's mixture for medium loam"—a famous seedsman's prescription—at 32s. an acre had answered. Others who had done something of the same thing were G. A. Grey of Milfield, Wooler, whose thoughts so far back as 1833 had turned to laying down, and R. Hodgson Huntley of Carham Hall, Coldstream, who used the method known as "inoculation" or cutting out turf and relaying it in a particular way. George Thompson Dickinson of Wheelbirks on Tyne, who found grazing more to his taste than arable farming, had laid down the stiffer land on his farm since 1866 by much the same methods as Sir Edward Blackett.[9]

This tendency was emphasised by statistics quoted by John Coleman in his report to the "Richmond" Commission on Agriculture 1880:—

	1871 (Acres)	1881 (Acres)	
Corn crops	152,108	130,743	
Green crops	64,369	56,096	−36,000 acres
Rotation clover, etc.	91,006	85,662	
Permanent grass	336,207	417,184	+ 81,000 acres

He added that the county practised a stabilised kind of farming, although there were some variations and this is confirmed by the evidence of George Rea, Middleton, Alnwick; Sir Matthew White Ridley, Bart., M.P.; and George Turnbull, Lucker Hall, Belford, all of whom went up to London to give evidence to the Commission.

The improved system of Northumberland had been the cynosure of agricultural eyes in 1840; it was no less in 1880, but it had been improved by the extended use of the Leicester Cross in sheep; by the increased use of cake feeding and the new artificial manures;

by drainage and by the use of steam cultivation so that it had maintained its place in the forefront of English farming—but there is no statistical measure whatever of the area on which these improvements were made and their expansion is a matter of belief rather than knowledge. It is probable that the additional improvements were added to the great farms already in the hands of the great capitalist farmers who must advance with the times or drop out of the race.

DURHAM

Samuel Chrisp told the Select Committee on Agricultural Customs that

Figure 2.—A Herdwick ram and his shepherd. (From Frank W. Gannett, Westmorland Agriculture 1800–1900, 1912.)

Durham was one of the worst farmed counties in England in 1848. The farms were smallish but many up to the national average of 2 300 acres. Many were 50 acre, pair horse, or family farms that would today be called small-holdings. Nevertheless the four-or five-course rotation was followed on light land; on the heavy clays fallow, wheat, clover or peas and beans, oats was the improved practice but fallow, wheat, oats was still to be found thirty years later. Much of the old grass was "blue grass" that would only carry one to one and a half sheep an acre. This, in his opinion, ought to be drained, ploughed out and manured carefully.

Improvement had begun on the larger farms: but on the small the farmers were little more than common labourers who do everything for themselves. Elsewhere tile drains were being laid in every direction, farm offices constructed and large quantities of fertilisers and manures were being imported, "so that in a few years the face of the county will be quite altered." The light soils and rich grassland was already prosperous.[10] The farm which the Culley's had begun improving in the late 18th century had been occupied by Messrs. Heslop for 15 years before 1850. It included 380 acres arable and 110 acres of grass and was worked on a six-course rotation, swedes and some white turnips being grown, heavily manured with ten loads of dung and two cwt. guano. Peas were grown in place of one year's ley. Stores were bought in June or July and sold fat at Christmas; half-bred Leicester Cheviot hoggets were bought in April, kept on seeds in the summer and finished on turnips in the autumn. Mr. Atkinson of Seaham Hall farmed 480 acres only 60 being in grass and the heavy land was properly drained. Two crops of potatoes figured in an eight-course rotation here. The Shorthorn, the famous Durham or Teeswater breed were popular and fine Cleveland Bay horses were bred.[11]

By 1868 a lot of necessary drainage had been done at 5 per cent interest (rent) by the landlords or they supplied the tiles and the tenants the labour, a very usual arrangement all over the country, and a fair system of tenant right had come into being. Still the fences were greatly neglected and many farm buildings were poor. The rotations remained the same on the different classes of land, although there was plenty of good manure, there was too much bare fallow to please a discriminating observer. A large number of horses

was bred for sale to the collieries and quantities of horse feed was also sold to the collieries. In the best districts the Leicester sheep was general but on the poorer and higher land of the west Cheviots and Blackfaces were more suitable. Bones, guano and superphosphate were increasingly used and liquid manure tanks were to be found on many farms.[12]

The great achievement of Durham was, of course, its fine Shorthorn cattle which were highly valued in all the civilised world, numbers of which went to the ranches of the American prairie and to the Pampas of the Argentine. The improvement of the Durham or Teeswater cattle was begun by George Culley who went from Durham to Northumberland in the last half of the 18th century and was carried on by the Collings Bros. of Kelton near Darlington well into the 19th century,[13] and of course continued strongly after the Herd Book was started: but this story has been told too often to need repetition here.

Naturally enough with this emphasis on cattle and horse breeding and sheep farming the Durham farmers were interested in the quality of their grazing but the 1875 *Report on Laying Down* (see f.n. 9) did not have very much to say about this development in the county. W. Steward, agent to the Earl of Durham farmed 1,784 acres on the Lambton Castle estate as manager and had laid down about 80 acres of heavy land since 1860 because of the high price of stock, the dearness and scarcity of labour caused by the demand from the collieries, and the need for more grass and hay for colliery horses. This was no very large proportion of his acreage. The method was to take a crop of oats out of lea, drain, and fallow well, and cultivating deeply as well as giving heavy dressings of manure and liming if necessary. The seeds were sown without a crop and grazed the first two seasons by young cattle and sheep and top dressed with artificials. The ordinary rotation also had been extended by leaving rotation grasses down for three years instead of two and the old pastures improved by manures and by feeding roots and cake on the land.

A few years later, on the 25 March, 1881, Samuel Rowlandson described his system to the Richmond Commission. He farmed a large acreage at Newton Morrell near Darlington and had laid down 120 to 130 acres at his own expense. He bought in stores in autumn and about 60 cows in calf and sold out cows as they became due. His livestock in 1878 was eight cows, 128 two-year-olds, 95 yearlings; 708 sheep, 340 lambs; 37 pigs and 22 horses. The cattle were all Shorthorns and the sheep Leicesters and Lincolns. He followed common practice in the four-course or five-course rotation according to soil and used about £600 each of cake and artificials annually. He said that a great deal of Government drainage, i.e., assisted by Government loans, had been done in the county between 1858 and 1864 but that much of it had failed.

Durham was a county where its famous breed of cattle had been developed and was maintained during the four decades. The arable farming did not change very much on the various types of holdings and soil but the sheep stock had possibly been improved. On the whole with a possible but only slightly remarked increase in the use of artificial manures and concentrates on the larger farms and the intensification of their productivity the advances in the county can only be estimated as normal.

CUMBERLAND

In the early years of the 19th century Cumberland had been fortunate in at least one of her sons, John Christian Curwen, founder of the Workington Agricultural Society, who organised an annual event at his Schoose Farm that has never reached the fame of the Wooburn sheep shearings, but which not unjustly has allowed me to dub him the "Coke" of Cumberland.[14] The good work he did for the improvement of local farming was followed up by other landowners notably Sir James Graham whose estate in 1820 is said to have comprised 340 farms of 90 acres each, which he had consolidated into 65 larger and more economic units by the 1840's. Redundant buildings had been torn down, hedges had been removed to make larger fields and drainage done by the landlord who charged the tenants 5 per cent on the capital cost by way of an increase in rent. It was said that there were 30 tileworks, mainly doubtless making draining tiles, in that part of the county. Curwen's attempts to grow corn had not met with success because the county was more suited to grazing and by 1850 the Shorthorns were beginning to spread through the county, and in place of the Cheviot and Blackface sheep a cross between the Leicester and the Cheviot were becoming popular.[15]

The standard set by the great landowners like Sir James Graham who had some 1,200 acres in hand at Netherby was high. The land was drained with tiles and open drains carefully maintained. All the soils were cropped with long leys, usually of four years' duration, different seed mixtures being used to suit the different soils. No tares or vetches were grown but experiments were being made with rape which was succeeding well. Turnips and swedes were always drilled and barley was sown on the turnip ground if it had been folded with sheep. Potatoes were drilled and never failed.

Cattle were fattened for the butcher, some being Shorthorns of Collings' descent, although Galloways were the general stock of the district. A first cross between Galloway and Shorthorn provided a good feeder. Few sheep were kept because cattle paid better. Clydesdale and Cleveland horses were used on the farm. These horses were bred by every farmer. Numerous pigs were kept and large quantities of bacon and ham sent to London and Liverpool. The dairy was largely followed for butter making.

The implements used were two-horse iron ploughs made locally and there were four of these on the home farm. Finlayson's harrow, a two-row drill for turnips and a one row for grass seeds were used. About 1840 the threshing machine had been given up to make work for the labourers. Farmyard manure and compost were so far all that was general.[16]

Other great farmers were Mr. Ferguson of Harker Lodge who had 700 acres and fed 3,000 hoggets and 200 cattle in summer; Mr. Turner of Moresby Hall near Whitehaven who farmed 340 acres, broke his lea for oats, followed by swedes and yellow turnips heavily dunged and laid the land down without a crop but with two cwt. of guano an acre; Mr. Jefferson of Preston Hows who did much the same; and Mr. Rigg of Abbey Holm who preferred polled Galloways to the improved Shorthorns fancied by most of his compatriots. In West Cumberland the enclosure of the commons in the previous 50 years was said to have reduced the number of "statesmen," small landowners who worked their own land and had been so greatly admired,

the farms then ranging between 50 and 150 acres in extent.[17]

William Dickinson wrote an *Essay on the Agriculture of West Cumberland* which won a premium offered by the Principal of St. Bees College and which was published as a 71-page book in 1850 and followed up this performance by a prize essay *On the Farming of Cumberland* which appeared in the R.A.S.E. Journal for 1852. These essays expand what has already been said and give a measure of the recent improvement on a 700-acre farm at Holme Eden. The measure is the flying stock fed during the summer season. In 1842 the animals numbered 80 beasts and 440 sheep fed on the produce of the farm: in 1851 some 149 beasts and 648 sheep were fed but the produce of the farm had to be supplemented with some bought turnips, a crop which had been grown by Philip Howard of Corby so long before as 1755 but which had only become general in the previous 25 years. More wheat too had been grown recently in the county and the average acreable yield had risen from 18 bu. to 24 bu.

The implements were iron swing ploughs made by local smiths on Wilkie's pattern although wooden could still be seen in use in 1852. A double mouldboard plough was to be found on every farm for moulding up potatoes and turnips and a turnwrist was used on hillsides. As elsewhere there was a large variety of harrows. The harvest was got by the hook and sickle but the scythe was coming in. Threshing machines were usual in the grain-growing districts, there having been 30 bu. in West Cumberland in 1849. Drills were slowly creeping into use, some of which were private property, others kept by subscription and a few for hire. Manure drills were used for bone dust, guano, etc., but all were too dear for the small farmer. Grubbers like Finlayson's were to be seen and a few Crosskill's clod-crushers but the county had its own peculiar type of clod-crusher made of planks with overlapping edges, forming a ribbed bottom. This implement could be inverted and used as a sledge on the hillsides. A reaper had been invented by Mann of Raby Cote, Holme Cultram in 1832 but it delivered the swathes in a confused state and had never been entirely perfected. Haymaking machines were thinly spread because they were costly, but the Cumberland farmers were "as deeply imbued with the onward spirit of the times as those of any county can be."

The high wages earned in the ironworks and collieries had by 1874 led to an increased demand for beef and mutton and as these were more generally eaten men left off eating bacon and pork, the former staple flesh. This demand added to the demand for stores for finishing in Yorkshire, Lincoln and Norfolk is reflected in *Agricultural Statistics* almost as soon as they began to be collected:

	Cattle	*Sheep*	*Pigs*	*Turnips*	*Mangold*
1866	109,225 ('67)	525,964	40,742	33,263 acres	381 acres
1873	128,538	561,573	28,229	35,259 acres	1,565 acres

The cultivation of cereal crops declined, oats by nearly 7,000 acres or 10 per cent of the acreage grown in 1866 and even potatoes dropped from 12,137 acres to 11,219 acres. Not only were cattle bred in the county but Irish and Scottish stores were acquired as they had been for a long time for summer grazing and resale and for stall or yard feeding in

the winter. So late as 1825, wrote Thomas Farrell, many farmers were prohibited from keeping sheep: by 1874 a good flock was looked upon as a sign of prosperity. The Leicester was the prevailing breed and outstanding herds were kept by Jefferson of Preston Hows; Fox of St. Bees Abbey; Jackson of Calva; Twentyman of Edderside and Joseph Bell of Scale Hill, Lazonby. There was a ram market at Cockermouth so local farmers were able to get good rams at six to ten guineas each. Here as all across the hills a cross between the Leicester and the Cheviot was growing popular, but Norman of Hall Bank, Aspatria, kept Lincoln longwools, quite an exception.

Although the arable area was falling there had been marked improvement in the implements in the 21 years before 1874. Reapers, mowing machines, hay rakes, tedders, oilcake breakers, pulpers, grinding mills, double furrow ploughs had all been introduced and steam cultivation had made a little but not very marked progress.[18]

With this development Evans and Bowstead naturally found a good deal in the county which they could include in their *Report on laying down land to permanent pasture* and naturally Robert Jefferson of Preston Hows, Whitehaven, whose new Leicesters called forth Farrell's praise, had been active in this way. From 1846 the predatory habits of the mining population had determined him to increase his permanent grass and in the interval he had increased it from 125 acres by 60 acres of new pasture, no small proportion of a farm of 400 acres. He had also formed the habit of keeping his seeds down for two, three or even four years. Similarly David Ropley of Shalton Hall, Cockermouth, had laid down 90 acres of his 320 since 1864; Pattinson of Hayton, Crosshill, Wigton, and J. C. Toppin of Musgrave Hall, Skelton, had done the same, the last some 70 acres of his 320.

Clearly there had been improvements in the farming systems followed in Cumberland. Better types of cattle and sheep were widely dispersed through the county; large numbers of new implements, at least large enough to impress observers, had been bought; liming was common and the new fertilisers were used as well as some cake for feeding; there had been a good deal of draining and new farm buildings had been put up; but of any kind of quantitative measure of all this there is none.

WESTMORLAND

The isolation of some of the farms in these northern counties is emphasised by the fact that so late as 1844 there were still farms in Stainmore to which there were no carriage roads and where no wheeled vehicles were used. Sledges were used to bring the hay home and the manure was carried to the fields in baskets. Trains of pack horses were still remembered by old people in 1868: but the clog wheel cart was used in 1844; dogs were seen in Kendal hauling carts the previous year. These conditions were first ameliorated when roads began to be made in 1757; when the Lancaster-Kendal canal was opened in 1819; and when the Carlisle to Newcastle railway, soon to be followed by others, was opened in 1838.

A great deal of enclosure and reclamation of commons had been done in the first half of the 19th century. Drystone walls were built; the land was drained by stone-filled drains; the surface pared and burnt and heavily limed. It was then ploughed for spring oats. Often this corn had been grown till no more would grow but heavy profits had been made where it had been possible to grow wheat, barley, oats, turnips and potatoes, the better farmers having adopted a

system of seeding down the land after crops by 1850. After 1870 reclaiming fell into disuse, and there was a tendency to revert to worse conditions than before.

The dairy played a good part in Westmorland agricultural economy but there was little change in the methods before 1880. Before 1860 the butter was salted and put up in 56-lb. firkins, but after that date it was sold unsalted in one-pound parcels. Lady Bective, wishing to stimulate improved methods, offered prizes for butter at Kendal Agricultural Show in 1869 but as there was no result the offer was withdrawn in 1898.

The Blackface sheep and Herdwicks still remained but there had been all sorts of crosses, Cheviots, Leicester and Lincolns being used and some Southdowns by some of the more adventurous. The arrangement was much the same as in the other hill counties.

Bakewell's improved Longhorn cattle were descended from Westmorland stock, Webster of Canley having used a bull from the county in the 18th century and Bakewell having used Canley stock and also bulls directly from Westmorland: but by 1850 the Longhorns had given place to the Shorthorns which Lord Lonsdale had begun breeding in 1810. There was some breeding of pedigree stock in the county, and of course Scots Kyloes and Galloways were bought in at Brough and other fairs for a season's feeding before being sent further on their way south as they had been for at least 150 years. Stores were also imported from Ireland: but the farm buildings were poor, some of the calf boxes or hovels might have been taken for model dungeons in 1878.

Poultry and pigs had never played a large part in the county: nor had horse breeding except that of the semi-wild fell ponies which could be seen used at two, three or even four in a plough. The iron Scotch plough had been intro-

FIGURE 3.—A Westmorland dale farm. (From Frank W. Gannett, Westmorland Agriculture 1800–1900, 1912.)

duced early in the 19th century but between 1820 and 1850 local smiths captured the trade, the most noted ploughwrights being Harling of Sedgwick, Wm. Garnett of End Moor and Stainton of Milton and Williamsons of Stainton, later of Kendal, were advertising a wide range of implements in 1850 including threshing machines, corn crushers, chaff-cutters, oilcake breakers, turnip cutters, iron cheese presses and barrel churns. A two-horse mowing machine did 22 acres of contract work in 18 hours in 1861, and a little later W. & A. Fell of Troutbeck Bridge achieved some fame as the makers of a one-horse mower, and McCormick's reaper was tried at Boustead's Farm, Hackthorpe Hall, near Lowther, in 1851. Steam threshing machines were introduced about 1860 and steam ploughing was tried by a few farmers in the early seventies but it did not do. The work was done by the Border Counties Steam Cultivation Co. Double furrow ploughing also became popular about 1870, and of course the new manures were used on the larger farms.[19]

The fact that grazing was taking the place of arable was emphasised again by Cragston Webster in 1868: but he mentions the odd four-course of oats, swedes, oats, seeds. By this time every farmer of any account was reputed to keep a Shorthorn bull and stores were sent to Craven in the spring. Of those summered in the hills many went to be fed on turnips in Scotland or to low farms in the county, some still going to Norfolk.[20]

A good many farmers too were laying down land to grass and some were leaving seeds down for three years instead of two, but there are always differences about methods of farming and Lt. Col. Hugh Rigg thought highly farmed arable carried more stock than grass so he had reduced his seeds from two years to one. Nevertheless he had between 1862 and 1875 laid down 162 acres of the 488 he had at Crossrigg Hall. He had apparently some idea of going round the farm in the way often proposed nowadays. He had tried by all possible means to improve ancient grass but found it very difficult. On the other hand Admiral R. Elliott of Langton Field, Appleby, had not laid any land down but had added one year to the normal two for the ley thus increasing the seeds by one-third. Alec. Fulton of Sedgwick near Kendal had since 1867 put down 128 acres of 437 acres he occupied in 1875. James C. Boustead of Hackthorpe Hall, whose land was at 800 ft. altitude had only laid down 40 acres of his 350 because of the increasing cost of labour and the rising price of livestock and also because the climate suited stock better than crops. For the same reasons James Mitchell of Howgill Castle began laying down in 1857 but the report does not state how much.[21]

Some indication of the reduction of the area under arable that was being rapidly made is given by the following figures from *Agricultural Statistics:*—

	Corn Crops	*Green Crops*	*Rotation Grasses*	*Permanent Pasture*
1870	23,298	11,729	22,336	168,229
1879	19,429	10,335	15,743	199,355

the total acreage of the county being some 500,000 acres.

The Royal Agricultural Society Farm Prize Competition was held in Cumberland and Westmorland in 1880,[22] but it is unnecessary to attempt to summarise the descriptions of the competing farms here because they were worked on the systems already described.

LANCASHIRE

The whole county of Lancashire was condemned in what must have been far

too sweeping an assertion by two writers of the 1840's. Lawrence Rawstorne[23] said there was not really one good grass field in the county, that 22 bu. of wheat was considered a fair crop, that it was not unusual to grow blendings, that few peas and beans were grown but more vetches and still more weeds and all sorts of rubbish. The farms had been subdivided in the days of hand-loom weaving and the land exhausted during the wars by wheat growing. There was one good spot. The improvements at Lytham had shown what could be done and he himself had suggested means whereby the output could be trebled. Lavergne went even farther. He called the county an immense morass shut in between the sea and the mountains, a very unjust view, but on Lord Derby's farms drainage was done by the landlord at 5 per cent increase in rent and here very heavy manuring with supplies obtained from town stables gave remarkable results with roots and potatoes. Some parts got two crops of potatoes a year and swedes often yielded 40 ton an acre.

No better opinion was held by William James Garnett.[24] The county was ill-drained, badly cultivated and neglected. The north was rather better than the south and the great landowners had set an example. Garnett was at a loss to explain this condition of farming when the industries of the county were so progressive. In the southern parts oats and wheat were the most popular crops but some barley was occasionally grown. Potatoes were largely grown at Ormskirk and Warrington. Turnips and green crops were recent introductions: but near the towns the grassland was undisturbed being used for the production of butter and cheese as at Clitheroe and Whalley. All this land needed draining and Sir Robert Peel had set the example by draining his at Accrington. Part of Chat Mess had been reclaimed by great efforts but a great deal was still in a state of nature. Between the Ribble and the Lune the hill men were old established and conservative and the largest farms were 250–300 acres with mountain grazing containing plenty of rushes. The stock was milch cows and calves, inferior Blackface sheep, a pig or two and perhaps two horses. Occasionally a crop of oats was taken, the manure was kept for the meadows and wheat bread was a rarity here. The lower lands were little improved except by a few landowners, the arable looked ploughed out, and rushes and other rubbish in the furrows showed the want of draining. The farmers were short of capital and of energy.

The Fylde had been greatly improved by the landowners who had done arterial drainage and bought in Scotsmen as tenants of 400-acre farms, and the mosses on the Wyre were being reclaimed, two bright spots in a dull county: but the Furness district was the redeeming feature of Lancashire farming. Here there were two classes of farmers the large landowners and the small freeholders. The modern rotation than was oats, oats, turnips, manured, or potatoes, barley, seeds for two or three years. For manures lime with salt and marl was used on the mosses, sea-sand was used in Cartmel: bones were being very generally used as a top dressing for grass and turnips but guano was preferred for potatoes, and of late years Finlayson's harrow and two-row turnip drill were used near Lancaster and some horse threshers had been introduced in recent years. Things like Ducie's cultivator were used on gentlemen's farms.

The great landowners here as elsewhere were setting a good example. On the Earl of Derby's estate and that of

Lord Sefton useless fences had been grubbed, draining was going on, good roads had been made and better buildings put up. Here the rotation was wheat, barley, seeds grazed and then mown for two years. Yields were high, wheat 40 bu.; barley 60 bu.; hay two tons at the first and one and a half at the second cut. Where town manure was to be had it was used very heavily indeed. Longton of Rainhill near Prescot used 800 tons of town stable manure annually on 160 acres; the farmers near Manchester did the same but of course not all of them. One occupier of 156 acres bought 3,000 tons; another on a holding of 165 acres bought 1,360 tons and a swede crop often yielded 40 tons. Similarly the potato crop, then well established about Ormskirk were very heavily manured. On the Fylde dairy farms the stock were improved Longhorns.[25]

The Longhorns had been given up in most of the county, their favour in Bakewell's eyes having been lost when the improved Shorthorns spread over the county, but Lancashire has the honour of being the home of the animals upon which the first great British cattle breeder worked. In 1876 it was thought that the breed had small chance of dying out in its native district although it was as great a curiosity as a mastodon on the bulk of English farms. If the old pictures were to be trusted there were beasts as good or better on local farms then and the Sparkenhoe Club had 30 entries in 1861. The Longhorn gave rich but a rather smaller yield of milk than the Shorthorn and was an excellent butcher's beast when ripe. They fed well "on what you give them" although delicate as calves and it then seemed possible that the breed might return to its old-time popularity. One breeder, Tomlinson of Lee Lane, Admaston, Rugeley, claimed that his family had bred Longhorn cattle on that farm for 280 years and Chapman's herd, dispersed in 1873, had been founded in 1756.[26]

When attempts had been made to reclaim the mosses and other waste land the attempt had often been to make good pasture. George Drewrey of Holker, Cark-in-Cartmel, took in hand a poor cold clay farm in 1854, broke it out of grass, gave it a summer fallow, applied four cwt. of Peruvian guano and sowed grass seeds. A part had since been top-dressed. This was so successful that the rent went up from 19/— to 30/— an acre. Drewrey had also laid down, through a regular course of cropping,

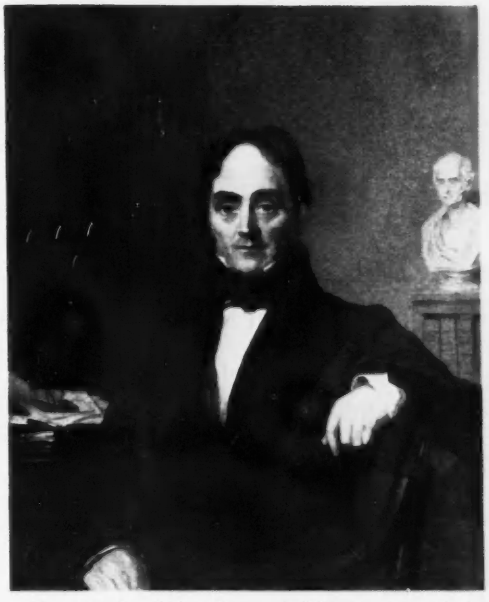

Figure 4.—John Grey of Dilston, one of the pioneers in Northumberland farming. (From a portrait in the *Farmer's Magazine*, 2nd Series, Vol. 14, 1846.)

and then seeded, generally without a nurse crop, 130 acres reclaimed from Morecambe Bay. Peter Blundell of Ream Hills, Kirkham, and Henry Neild of the Grange, Worsley, both occupied land almost wholly reclaimed bog. The former had successfully laid down the heavier fields but the latter found that

his Chat Moss land will always revert to its original herbage. He thought the best way of improving old grass was to use homemade manure from well-fed stock, well rotted by constant saturation with tank water.[27]

Two years later the Royal Agricultural Society Annual Prize Farm Competition was carried out from Liverpool and in Lancashire seven arable farms and seven dairy and stock farms were reported on.[28] The first prize was won by Mrs. Birch of Netherton near Aintree and the six other arable farms were those of John Wright, Stared Farm near Croxteth Park; William Scotson, Aigburth near Liverpool; William Gore Ashton, Roby Farm, near Prescot; Edward Murker, Stand Park Farm near Aintree; Mark Wright, Gill Moss Farm, Croxteth, and Robert Whalley, Mill Green, Bold near Warrington. All these were in the much condemned South of the county, but their entry is a justification for belief that they were the better farms of that district and their number indicates that a spirit of better farming was abroad in that part of the county. The dairy and stock farms were in the north and were those of Kendall, Harbarrow near Ulverston; J. Woodhouse, Scale Hall near Lancaster; F. Harrison, Hutton Grange near Preston; Richard Mackareth, Waterside Farm, Aston cum Stodday near Lancaster; John Cotten, Wall House Farm, Scotforth; John Pownall, Ireland's Farm, Halesworth; John Pilkington, Morten Lane, Burscough.

Already the bad seasons that were to culminate in the terrible weather of 1879 were upon these people like all others, but John Coleman told the Richmond Commission in his Report that the depression had not been so bad here because of ample local markets. He estimated that the rotation crops had fallen by 9,000 acres in the decade ending 1881 but otherwise the farming was the same. Near Liverpool the farms averaged about 150 acres and many potatoes were grown. R. Scotson of Aigburth kept his clover ley down two years, broke up half for potatoes and roots and part for oats, then grew wheat followed by oats and barley with seeds. He had a small dairy for liquid milk. Whalley of Farnworth did much the same. He used the free gas lime from Widnes at 10–12 tons an acre and had cut all his hedges with a Hornsby hedge cutter. Much the same sort of thing was done on the Sefton estate. There was one market garden of 11 acres near Manchester run on a very varied system that included some rhubarb. The Fylde was the most agricultural part of the county, but a good deal was then being laid down to grass. There had been some land reclamation near the coast in this district. The Furness arable was worked on a five-course and the hill farms remained comparatively small though this part of the county had long been famous for good farming.

Exactly how to estimate what changes had taken place here is difficult to imagine though clearly there had been some.

YORKSHIRE

Two reports[29] on the West Riding of Yorkshire made at an interval of thirty years are almost in identical terms. Near the large towns there was more grass than arable, though the latter got all the available town manure and consequently the grass was declining in productivity because it was used for dairy products and the fertility sold off in them. The rotations practised were very various and often two wheat crops were taken in succession, indeed some farmers grew wheat year after year for very long periods. A common rotation of the better sort was potatoes, wheat,

clover, potatoes, wheat or cabbages. On the magnesian limestone the four-course was followed and some red clover was grown for seed and some peas for sale in Leeds. Turnips got 10 bu. bones an acre and the wheat one and a half qts. of rape dust. Near Pontefract liquorice was a specialist crop. On the alluvial soils near the rivers flax, woad, teazels and carrots were largely grown, show the influence of the woollen industry. Round Bawtry, Tadcaster, Whixley Green, Hamerton and Boroughbridge a six-course was usual including a crop of tares for soiling horses and an extra crop of turnips. The barley here was specially fine.

On the millstone grit fallow, wheat, beans, the ancient heavy land system, was usual but here and there near Ripon and Otley an improved system had been introduced. In Craven the old Longhorn cattle still flourished and a few small sheep were kept on the mountain pastures. The Shorthorns had come to the middle and east of the Riding but there were many cross bred cattle and the Irish imports had not improved matters. Hunters were bred round Doncaster, Wetherby and Ripon but the draught horses were a mixed lot. The sheep had been improved by the large landowners who had brought in Leicesters and improved Lincolns and some Southdowns and on the moorlands a Leicester tup had been crossed with Border or Cheviot ewes. There was here a certain degree of stagnation but the farms were mainly on the small size, the majority about 80–100 acres, only a few of 300–500 acres and near the towns the small holdings of 10–50 acres occupied by the domestic hand loom weavers still remained. Charnock estimates that 100,000 acres had been added to the arable in the first half of the 19th century and the wheat yield raised from 22 to 30 bu. an acre. A good deal of pipe and tile draining had been done.[30] The explanation of the apparent lack of progress is that the possibilities were small especially on the higher land but some land was reclaimed year by year. The first necessities were to make drains, make roads, enclose fields and to build farmhouses, so a great deal of capital had to be put out before the actual work of farming this sparsely populated countryside could be started.[31]

I have discussed the developments in the North and East Ridings *in extenso* elsewhere[32] so it is perhaps unnecessary to go into any detail here. I will quote two paragraphs.

The old wooden plough still "disgraced" some farms in 1848, but in addition to the influence of its prizes for good farming the Yorkshire Agricultural Society had done a great deal to introduce improved implements, and various factory made articles were used. In addition to Crosshill's Clod crushers, Finlayson's improved harrow was used on the light soils, the Ducie cultivator and some stubble parers were other examples.[33] Between Thirsk and Northallerton our American pedestrian remarked that he passed through a highly cultivated district "and saw for the first time several reaping machines at work in the fields. . . . The grain was not very stout nor was it lodged."[34] This does not, of course, mean that these reaping machines were the first in use either in Yorkshire or in England, but that they were the first Burritt had seen in this country.

The lines of development that were apparent in 1850 continued until the depression of the 70's and Coleman's report to the "Richmond" Commission that the main system was the four-course rotation as it had been 30 years before. Drainage, the landlord supplying the tiles, and the tenant the labour to put

them in, had been done extensively with the help of the "Government" money but a good deal of it was done much too deep, five and a half feet at first, and had to be done shallower a second time. Still more would have to be done again. The strong clay, the wheat and bean land, was going back to grass again.

Here as elsewhere great achievements had been made by the great landlords largely in the 18th and early 19th century and there is no measure of how much more widespread these improvements became in the four decades under review. Contemporary observers, Caird in particular, claimed that they had all over the country, but this is an observation based in personal experience alone.

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